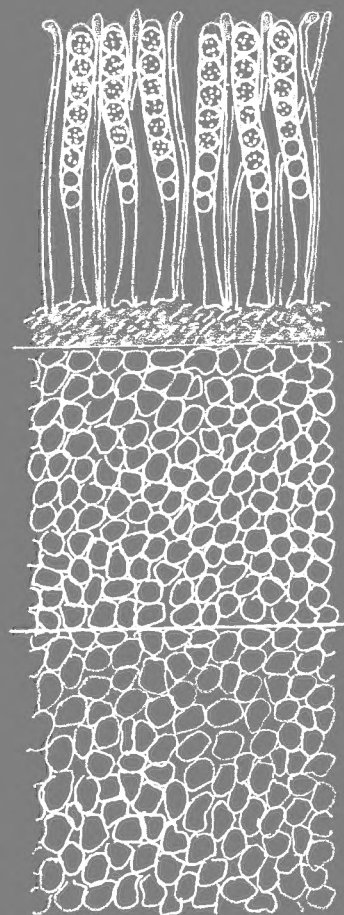


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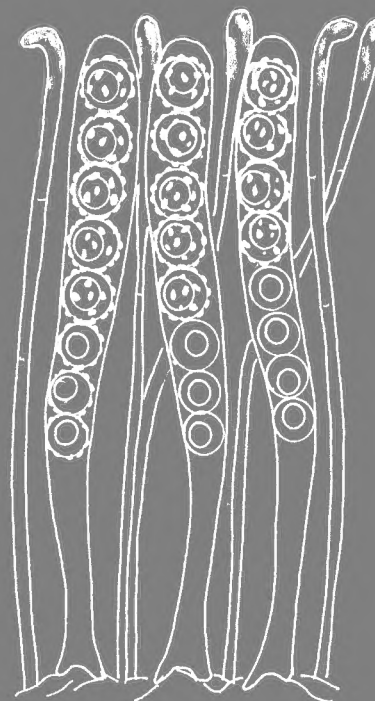
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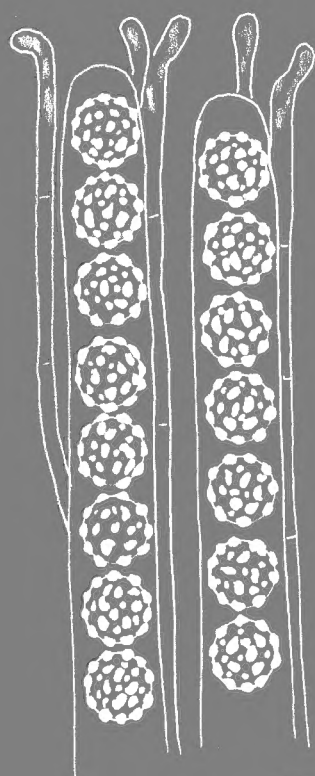


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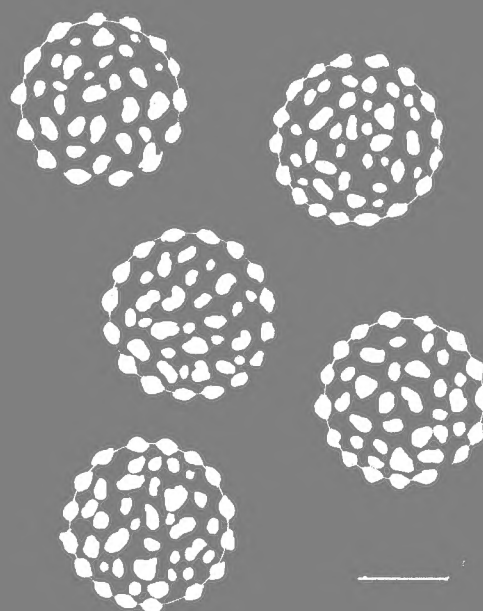


B

Marcelleina mediterranea sp. nov.
(Lantieri & Pfister — FIGURE 1, p. 467)
ANGELA LANTIERI, artist



C



D

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**Conidial fungi from the semi-arid Caatinga biome of Brazil.
New species of *Endophragmiella* and *Spegazzinia*
with new records for Brazil, South America, and Neotropica**

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Abstract — Two new species found on dead bark and fruit in Brazilian semi-arid region are described and illustrated. *Endophragmiella tuberculata* sp. nov. is characterized by obovoid, 1-septate, verrucose conidia, and can be distinguished from similar *Endophragmiella* species by the distal cells of its conidia with conspicuous tubercles. *Spegazzinia flabellata* sp. nov. has two types of conidia: *a*—globose to subglobose, simple, strong spinulose and *b*—co-planate, with four quadrangular cells, finely spinulose; it can be separated from earlier described *Spegazzinia* species by *a*-type conidia with conspicuous spines. *Dictyoarthrinium sacchari* is reported for the first time from Brazil. Furthermore, *E. collapsa* and *E. dimorphospora* are new records for Neotropica and South America respectively.

Key words — hyphomycetes, anamorphic fungi

Introduction

The genus *Endophragmiella* B. Sutton was proposed to accommodate two hyperparasitic species, *E. pallescens* B. Sutton (type species) and *E. canadensis* (Ellis & Everh.) B. Sutton (Sutton 1973). Presently, 75 species and one variety are accepted and distributed from temperate to tropical regions (Wu & Zhuang 2005). The genus is characterized by macronematous, mononematous conidiophores with integrated conidiogenous cells, proliferating percurrently and solitary euseptate or distoseptate conidia with rhexolytic secession (Sutton 1973, Hughes 1979). Four species have previously been reported from Brazil, viz. *E. fasciata*, *E. boewei*, *E. quadrilocularis* and *E. rigidiuscula* (Castañeda-Ruiz 1988, Gusmão et al. 2001, Marques et al. 2008, Leão-Ferreira et al. 2008).

However, *E. fasciata* R.F. Castañeda has been reassigned to *Repetophragma* as *R. fasciatum* (R.F. Castañeda) R.F. Castañeda, et al. (Castañeda-Ruiz et al. 2006).

Few genera of conidial fungi – *Arthrimum* Kunze, *Catenospegazzinia* Subram., *Cordella* Speg., *Dictyoarthrinium* S. Hughes, *Endocalyx* Berk. & Broome, *Pteroconium* Sacc. ex Grove, and *Spegazzinia* Sacc., representing approximately 45–50 species – have conidiophores arising and elongating from a cup-shaped cell called a conidiophore mother cell or a basauxic conidiophore (Hughes 1953, Somrithipol 2007). These genera are distinguished by the conidiogenous loci, the occurrence of setae and stroma, and the septation of conidia and conidiophores (Somrithipol 2007). According to the Index Fungorum database (www.indexfungorum.org), 23 species are clustered in the genus *Spegazzinia*, characterized by basauxic conidiophores and smooth, roughened or with conspicuous spiny, brown to dark brown conidia (Chen & Tzean 2000). The conidia of *Spegazzinia* are produced at the on apex of a basauxic filament and are usually two types, *a* and *b*; the *a* conidia are usually globose to subglobose, spinulose; the *b* conidia are multicellular, muriform, variously shaped, and usually smooth (Mercado-Sierra 1984).

Materials and methods

The region of “Serra do Ramalho” (13°30’S; 44°15’W), is one of the 27 areas of high biological importance for the Caatinga biome, and is very representative vegetation of the semi-arid region in Northeast of Brazil. This area occupies about 2000 km², within the municipalities Caririnha, Coribe, Feira da Mata, Serra do Ramalho, Cocos and São Félix do Coribe (Ministério Da Integração Nacional 2005). The “Serra do Ramalho” region is characterized by presence of calcareous rock, and the altitude rises from 600–800 m, with annual rainfall up to 1,500 mm (Moreno 2006). Field expeditions were made in November 2007 and February 2008 in Coribe, São Félix do Coribe and Serra do Ramalho. Leaf litter samples were placed in separate paper bags by locality and taken to the laboratory. The samples were placed in Petri dishes, which were placed inside polystyrene containers (150 L) with 200 mL of sterile water plus 2 mL of glycerol and incubated at room temperature (Castañeda-Ruiz 2005). Samples were examined at regular intervals for the presence of conidial fungi. Fungal structures were placed in polyvinyl alcohol on a microscope slide and preserved on dry substrates. All specimens are deposited in the Herbarium of Universidade Estadual de Feira de Santana (HUEFS).

Taxonomy

***Endophragmiella tuberculata* S.M. Leão & Gusmão, sp. nov.**

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FIGS. 1–7

COLONIAE effusae, brunneae. MYCELIUM partim immersum, partim superficiale, ex hyphis septatis, ramosis, laevibus, pallide brunneis. CONIDIOPHORA macronemata, mononemata, recta vel flexuosa, erecta, simplicia vel ramificata, septata, laevia, brunnea, 12–106 × 3.5–5.5 µm. CELLULAE CONIDIOGENAE monoblasticae, terminales et intercalares



FIGURES 1–7: *Endophragmiella tuberculata* (from the holotype HUEFS 136870).
 1–2. General aspect. 3. Detail of the percurrent proliferation (arrow). 4–5. Young conidia. 6. Detail of the rhexolytic secession of conidia (arrow). 7. Detail of the tubercles (arrow).
 (Bars = 10 μ m)

in conidiophoris incorporatae, cum proliferationibus percurrentes, cylindricae, laeviae, pallide brunneae. SECESSIO CONIDIORUM rhexolitica. CONIDIA solitaria, acrogena, 1-septata, obovoidea, verrucosa, simplicia, sicca, ad cellula basalis 6–7 μ m, cellula apicalis 8.5–12 μ m, tuberculata, pallide brunnea, 14.5–19 \times 10.5–18.5 μ m. TELEOMORPHOSIS ignota.

HOLOTYPE: BRAZIL BAHIA: Coribe, in corticis emortuis, 19.III.2008, leg. S.M. Leão-Ferreira, HUEFS 136870.

ETYMOLOGY: Latin, *tuberculatus* – in reference to the presence of tubercles on the conidia.

CONIDIOPHORES, macronematous, mononematous, straight or flexuous, erect, simple or branched, septate, smooth, brown, $12\text{--}106 \times 3.5\text{--}5.5 \mu\text{m}$. CONIDIOGENOUS CELLS monoblastic, terminal or intercalary, integrated, with conspicuous percurrent proliferations, cylindric, smooth, pale brown. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, acrogenous, 1-septate, obovoid, verrucose, simple, dry, basal cells $6\text{--}7 \mu\text{m}$ long, apical cells $8.5\text{--}12 \mu\text{m}$ long, tuberculate, pale brown, $14.5\text{--}19 \times 10.5\text{--}18.5 \mu\text{m}$. TELEOMORPH unknown.

NOTES: Among the described *Endophragmiella* species only two — *E. dingleyae* S. Hughes (Hughes 1978a) and *E. unisetulata* (Matsush.) S. Hughes (Hughes 1979) — resemble *E. tuberculata* in conidial ornamentation. However, *E. dingleyae* and *E. unisetulata* differ in their conidial morphology (spherical, 0-septate and obclavate, 2-septate, respectively).

Five species have been described as having obovoid, smooth, 1-septate conidia: *E. globulosa* (B. Sutton) S. Hughes (Hughes 1978c), *E. pinicola* (M.B. Ellis) S. Hughes (Hughes 1979), *E. resinae* P.M. Kirk (Kirk 1981), *E. taxi* (M.B. Ellis) S. Hughes (Hughes 1979), and *E. uniseptata* (M.B. Ellis) S. Hughes (Hughes 1979). The apical conidial cells of *E. taxi*, *E. uniseptata*, and *E. pinicola* are larger than in *E. tuberculata*. Although *E. globulosa* produces similarly shaped conidia, it can be separated from *E. tuberculata* by its discolored conidia. *Endophragmiella resinae* somewhat resembles *E. tuberculata*, but the obovoid to pyriform conidial shape of *E. resinae* is quite distinctive. The new species is named *E. tuberculata* for its peculiar conidial ornamentation.

***Spegazzinia flabellata* S.M. Leão & Gusmão, sp. nov.**

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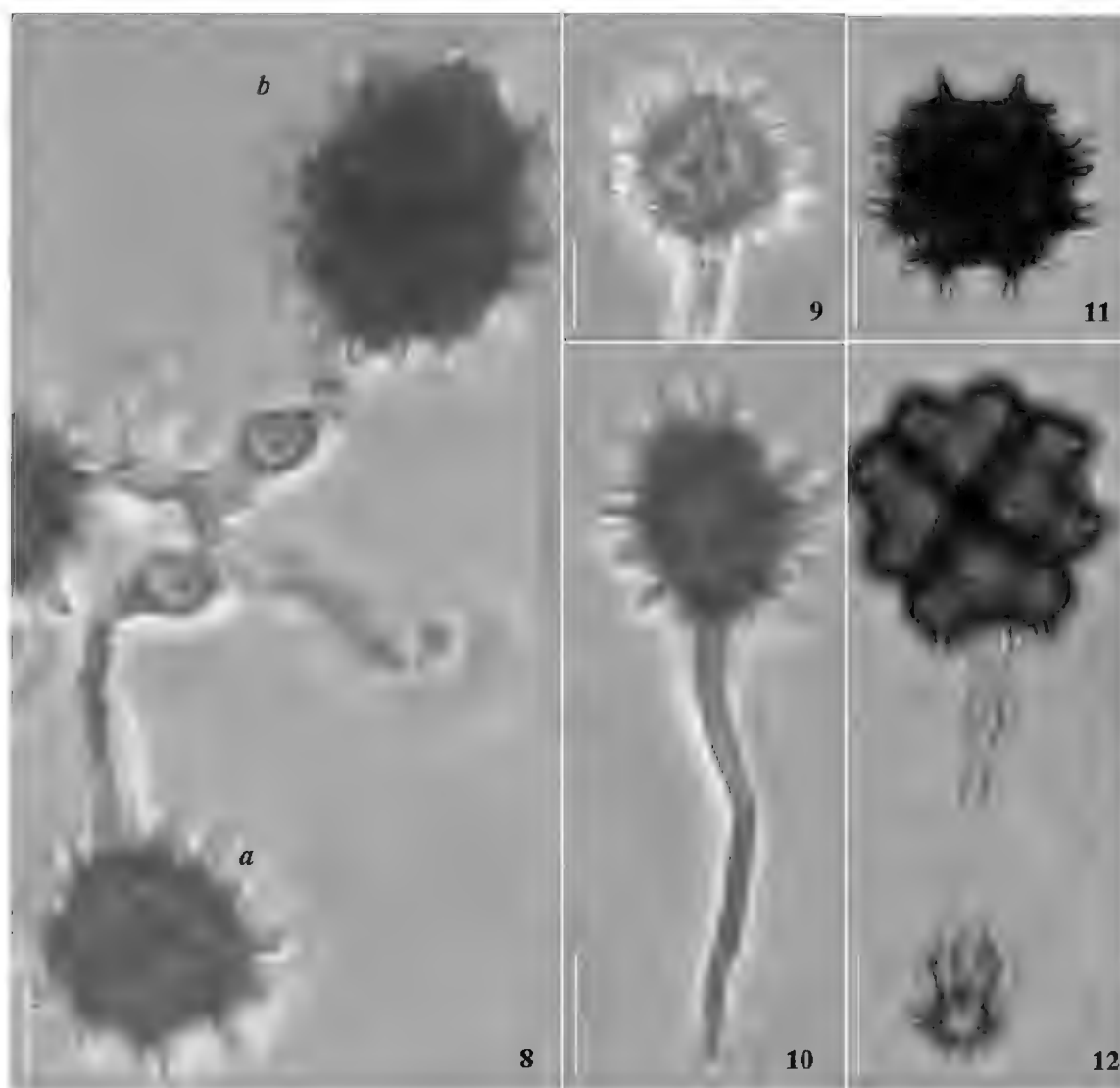
FIGS. 8–12

MYCELIUM plerumque in substrato immersum, ex hyphis septatis, ramosis, laevibus, pallide brunneis. CELLULA MATRICIALES conidiophori cupulate vel lageniformis, pallide brunnea vel brunnea, $5\text{--}7 \times 4\text{--}5 \mu\text{m}$. CONIDIOPHORA macronematosa, mononematosa, basauxica, simplia, recta vel flexuosa, basim pallide brunnea, apicem brunnea, $8\text{--}42 \times 2\text{--}3 \mu\text{m}$. CELLULAE CONIDIOGENAE monoblasticae, terminales, in conidiophoris incorporatae. SECESSIO CONIDIORUM rhexolitica. CONIDIA solitaria, simplicia, brunnea vel atro-brunnea, duorum generum: a) globosa vel subglobosa, 4-cellulare, spinulosus, brunneae vel atro-brunnea, $11\text{--}14 \times 8\text{--}16 \mu\text{m}$; spinis $1.5\text{--}4 \mu\text{m}$ longis; b) coplanata, quadrangularis, 4-cellulare, cruciatus septata, latere lobatis irregularis, laeviae vel minute spinulosus, $15\text{--}18 \times 13\text{--}18 \mu\text{m}$. TELEOMORPHOSIS ignota.

HOLOTYPUS: BRAZIL. BAHIA: Coribe, in fructus emortuis, 16.III.2008, leg. S.M. Leão-Ferreira, HUEFS 136875.

ETYMOLOGY: Latin, *flabellatus* – in reference to the conidial morphology.

CONIDIOPHORES macronematous, mononematous, basauxic, simple, straight or flexuous, smooth, pale brown, $8\text{--}42 \times 2\text{--}3 \mu\text{m}$, arising from cupuliform



FIGURES 8–12. *Spegazzinia flabellata* (from holotype HUEFS 136875). 8. General aspect, with two kinds of conidia *a* and *b*. 9–10. Type *a* conidia. 11–12. Type *b* conidia.

(Bars = 10µm)

to lageniform, unbranched mother cells, $5\text{--}7 \times 4\text{--}5 \mu\text{m}$. CONIDIOGENOUS CELLS monoblastic, terminals, integrated. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, with two kinds: type-*a*, globose to subglobose, 4-celled, with conspicuous scattered spines, brown to dark brown, $11\text{--}14 \times 8\text{--}16 \mu\text{m}$; spines $1.5\text{--}4 \mu\text{m}$ long; type-*b*, co-planate, 4-celled, cruciately septate, quadrangular, irregularly lobed, smooth or finely spinulose, brown to dark brown, $15\text{--}18 \times 13\text{--}18 \mu\text{m}$. TELEOMORPH unknown.

NOTES: A thorough survey of literature reveals that only *Spegazzinia lobulata* Thrower (McLennan et al. 1954) and *S. sundara* Subram. (Subramanian 1971) resemble *S. flabellata* in producing two types of conidia with lobate type-*b* conidia (TABLE 1, p. 6). The conidia are smooth type-*b* in *S. lobulata* and larger and irregularly lobate in *S. sundara* (Chen & Tzean 2000, Ellis 1976). *Spegazzinia flabellata* differs from these species by the presence of delimited

TABLE 1. Synopsis of the species related to *Spegazzinia flabellata*

SPECIES	type- <i>a</i> conidia		type- <i>b</i> conidia	
	Diam. (µm)	Spines (µm)	Diam. (µm)	Spines (µm)
<i>S. flabellata</i>	11–14	2–4	15–18	1.5–4
<i>S. intermedia</i>	—	—	18–28	absent
<i>S. lobulata</i>	20	12	17–22	absent
<i>S. sundara</i>	10–30	9–12	17–25	inconspicuous

lobes and spines on the type-*b* conidia. *Spegazzinia intermedia* M.B. Ellis has type-*b* conidia similar to those of *S. flabellata* but does not produce type-*a* conidia (Ellis 1976).

Dictyoarthrinium sacchari (J.A. Stev.) Damon, Bull. Torrey bot. Club 80: 164. 1953.
FIGS. 13–16

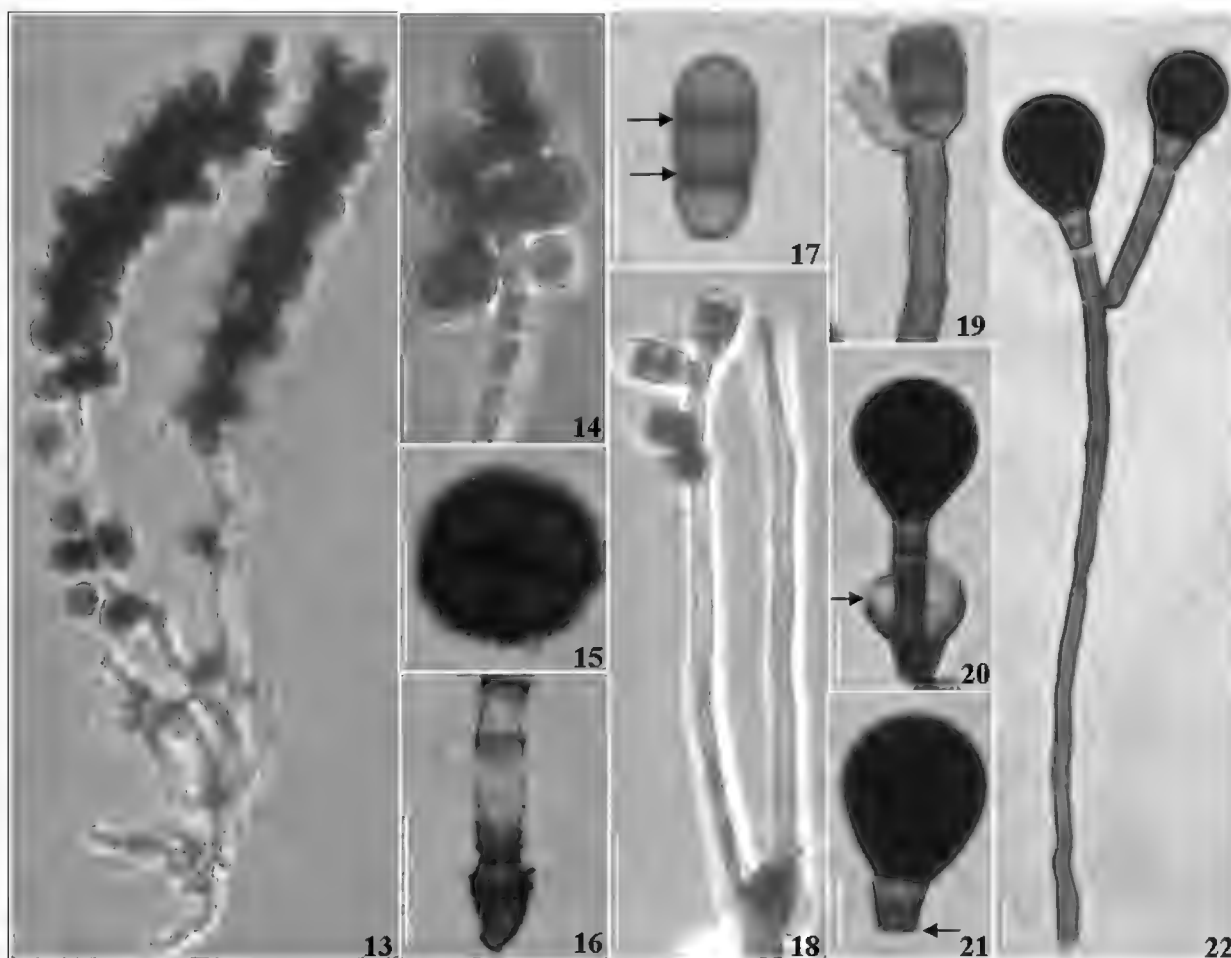
≡ *Tetracoccusporium sacchari* J.A. Stev., J. Dept. Agric. Porto Rico 1: 225. 1917.

CONIDIOPHORES macronematous, mononematous, basauxic, simple, straight or flexuose, septate, smooth, hyaline, 45–240 × 4.5–6 µm, arising from a cupuliform, unbranched, verrucose, mother cell, 3–7 × 3.5–4.5 µm. CONIDIOGENOUS CELLS polyblastic, terminals, intercalary, integrated, cylindric, verrucose. CONIDIAL SECESSION schizolytic. CONIDIA solitary, cruciately septate, quadrangular to subspherical, dry, verrucose, brown, 9–15 µm diam., 7–9 µm wide.

SPECIMENS EXAMINED: BRAZIL. BAHIA: São Félix do Coribe, on decaying leaves of unidentified dicotyledon, 11.XII.2007, coll. S.M. Leão-Ferreira, HUEFS 136891; Serra do Ramalho, on dead bark of unidentified dicotyledon, 7.I.2008, coll. S.M. Leão-Ferreira, HUEFS 136892; on dead flower of unidentified dicotyledon, 11.I.2008, coll. S.M. Leão-Ferreira, HUEFS 136893; Coribe, on decaying fruit of unidentified dicotyledon, 7.III.2008, coll. S.M. Leão-Ferreira, HUEFS 136894.

DISTRIBUTION: Cuba, Ghana, India, Malaysia, Puerto Rico, Solomon Islands, Venezuela, Zambia (Ellis 1971, Matsushima 1971, Mena-Portales & Mercado-Sierra 1987, Mercado-Sierra 1980, 1984)

NOTES: *Dictyoarthrinium* is distributed worldwide (Kirk et al. 2001) and comprises seven species. It is characterized by mononematous or synnematus conidiophores with integrated conidiogenous cells and septate conidia (Somrithipol 2007). *Dictyoarthrinium africanum* S. Hughes (Hughes 1952), has 16-celled conidia; however the other six species have cruciately septate 4-celled conidia (Somrithipol 2007). *Dictyoarthrinium rabaulense* Matsush. (Matsushima 1971) and *D. synnematicum* Somrith. (Somrithipol 2007) differ from *D. sacchari* in conidial diameter and synnematus conidiophores, respectively. *Dictyoarthrinium lilliputeum* P. Rag. Rao & D. Rao and *D. microsporum* P. Rag. Rao & D. Rao (Rao & Rao 1964) possess conidiophores and conidia smaller than those of *D. sacchari* (Somrithipol 2007). The conidiophores in our examined material are larger than those species reported



FIGURES 13–16: *Dictyoarthrinium sacchari*. 13. General aspect. 14. Basauxic development 15. Conidium.. 16. Conidiophore mother-cell;

FIGURES 17–19. *Endophragmiella collapsa*. 17. Conidium. 18. General aspect. 19. Detail of the proliferation;

FIGURES 20–22. *Endophragmiella dimorphospora*. 20. Detail of the cup. 21. Conidium with detail of rhexolytic secession. 22. General aspect

(Bars = 10µm)

in the literature (Ellis 1971, Matsushima 1971, Mercado-Sierra 1984). This is the first record for Brazil.

***Endophragmiella collapsa* (B. Sutton) S. Hughes, Fungi Canadenses (Ottawa):**

no. 126. 1978.

FIGURES 17–19

= *Endophragmia collapsa* B. Sutton, Mycological Papers 132: 54. 1973.

CONIDIOPHORES macronematous, mononematous, simple or branched, straight or flexuous, septate, smooth, brown, 100–236 × 3–5 µm. CONIDIOGENOUS CELLS monoblastic, terminal, integrate, cylindric, percurrent proliferation, pale brown. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, ellipsoid to ovoid, 2-septate, brown at septa, simple, dry, basal cell hyaline to pale brown, apical cell dark brown, frequently collapsed, 14–17 × 7–9 µm.

SPECIMENS EXAMINED: BRAZIL. BAHIA: Coribe, on dead bark of unidentified dicotyledon, 6.I.2008, coll. S.M. Leão-Ferreira. HUEFS 136880.

DISTRIBUTION: Canada, former Czechoslovakia (Holubová-Jechová 1986; Sutton 1973).

NOTES: Among the species with ellipsoid and 2-septate conidia, *E. biseptata* (Peck) S. Hughes (Hughes 1978b), *E. hughesii* D. Hawksw. (Hawksworth 1979), and *E. oblonga* (Matsush.) S. Hughes (Hughes 1979) all possess conidia larger than those in *E. collapsa*. According to Holubová-Jechová (1986), Hughes (1979), and Sutton (1973), the important diagnostic character for *E. collapsa* is the typically collapsed basal conidial cell. The Brazilian specimen has larger conidiophores than previously described material, and the conidial septa are also thicker and darker. This is the first record for Neotropica.

Endophragmiella dimorphospora (Awao & Udagawa) S. Hughes, N.Z. J. Bot. 17: 149. 1979. FIGS. 20–22
= *Endophragmia dimorphospora* Awao & Udagawa, Trans. Mycol. Soc. Japan 15: 99. 1974.

CONIDIOPHORES macronematous, mononematous, simple or branched, straight or flexuous, septate, smooth, brown, $28\text{--}273 \times 3\text{--}4.5 \mu\text{m}$. CONIDIOGENOUS CELLS monoblastic, terminal, integrate, percurrent proliferation, cylindric, smooth pale brown. CONIDIAL SECESSION rhexolytic. CONIDIA solitary, 1-septate, obclavate, simple, smooth, basal cell pale brown, with truncate base, apical cell dark brown, $19.5\text{--}31 \times 13.5\text{--}19.5 \mu\text{m}$.

SPECIMENS EXAMINED: BRAZIL. BAHIA: São Félix do Coribe, on decaying twig of unidentified dicotyledon, 20.XII.2007, coll. S.M. Leão-Ferreira. HUEFS 137808.

DISTRIBUTION: Australia, Cuba, Hong Kong, Japan, Kenya, Mexico, Republic of Mauritius, Taiwan, USA (Caretta et al. 1999, Castañeda-Ruiz et al. 1998, Dulymamode et al. 2001, Farr & Rossman 2008, Heredia et al. 1997, Hughes 1979, Matsushima 1980, 1989).

NOTES: *Endophragmiella dimorphospora* has been collected from soil, leaf litter, and other plant materials (Farr & Rossman 2008, Heredia et al. 1997). *Endophragmiella biconstituta* (Rambelli) Matsush., *E. globulosa*, and *E. resinae* are other species with 1-septate, smooth conidia with the apical conidial cell 1.5–3 times larger than the basal cell (Hughes 1978c, Kirk 1985, Wu & Zhuang 2005). *Endophragmiella biconstituta* differs in its obpyriform to subglobose and dark brown conidia while *E. globulosa* and *E. resinae* have hemispheric basal conidial cells. The material examined has larger conidia than species described in Hughes (1979), Heredia et al. (1997), and Matsushima (1975). This is the first record for South America.

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Literature cited

- Caretta G, Piontelli E, Picco AM, Del Frate G. 1999. Some filamentous fungi on grassland vegetation from Kenya. *Mycopathologia* 145: 155–169.
- Castañeda-Ruiz RF. 1988. Fungi cubenses. III. Instituto Investigaciones Fundamentales Agricultura Tropical “Alejandro de Humboldt”, C. Habana.
- Castañeda-Ruiz RF. 2005. Metodología en el estudio de los hongos anamorfos. In: Anais do V Congresso Latino Americano de Micologia, Brasília, Brasil, 182–183.
- Castañeda-Ruiz RF, Guarro J, Mayo E, Decock C. 1998. Notes on conidial fungi. XVI. A new species of *Dendryphiosphaera* and some new records from Cuba. *Mycotaxon* 67: 9–19.
- Castañeda-Ruiz RF, Gusmão LFP, Heredia G, Saikawa M. 2006. Some hyphomycetes from Brazil. Two new species of *Brachydesmiella*, two new combinations for *Repetophragma*, and new records. *Mycotaxon* 95: 261–270.
- Chen JL, Tzean SS. 2000. Three species of *Spegazzinia* (hyphomycetes) from Taiwan. *Fungal Science* 15(3, 4): 81–87.
- Dulymamode R, Cannon PF, Peerally A. 2001. Fungi on endemic plants of Mauritius. *Mycol. Res.* 105(12): 1472–1479.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
- Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.
- Farr DF, Rossman AY. 2008. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. [<http://nt.ars-grin.gov/fungalatabases/> (viewed online on October, 08, 2008)].
- Gusmão LFP, Grandi RAP, Milanez AI. 2001. Hyphomycetes from leaf litter of *Miconia cabussu* in a Brazilian Atlantic rain forest. *Mycotaxon* 79: 201–213.
- Hawksworth DL. 1979. The lichenicolous Hyphomycetes. *Bulletin of the British Museum (Natural History) Botany Series* 6: 183–300.
- Heredia G, Mena-Portales J, Mercado-Sierra A. 1997. Hyphomycetes saprobios tropicales. Nuevos registros de dematiáceos para México. *Revista Mexicana de Micología*. 13: 41–51.
- Holubová-Jechová V. 1986. Lignicolous hyphomycetes from Czechoslovakia 8. *Endophragmiella* and *Phragmocephala*. *Folia Geobot. Phytotax.*, Praha 21: 173–197.
- Hughes SJ. 1952. Fungi from the Gold Coast I. *Mycol. Pap.* 48: 1–91.
- Hughes SJ. 1953. Conidiophores, conidia and classification. *Can. J. Bot.* 31: 577–659.
- Hughes SJ. 1978a. New Zealand Fungi 25. Miscellaneous species. *N.Z. J. Bot.* 16: 311–70.
- Hughes SJ. 1978b. *Endophragmiella biseptata*. *Fungi Canadenses* 125: 1–2.
- Hughes SJ. 1978c. *Endophragmiella globulosa*. *Fungi Canadenses* 127: 1–2.
- Hughes SJ. 1979. Relocation of species of *Endophragmia* auct. with notes on relevant generic names. *N.Z. J. Bot.* 17: 139–188.
- Kirk PM. 1981. New or interesting microfungi 1. Dematiaceous hyphomycetes from Devon. *Trans. Br. Mycol. Soc.* 76: 71–87.
- Kirk PM. 1985. New or interesting microfungi XIV. Dematiaceous hyphomycetes from MT Kenya. *Mycotaxon* 23: 305–352.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth and Bisby's Dictionary of the fungi. 9th ed. CABI: Bioscience, Egham,

- Leão-Ferreira SM, Cruz ACR, Castañeda-Ruiz RF, Gusmão LFP. 2008. Conidial fungi from the semi-arid Caatinga biome of Brazil. *Brachysporiellina fecunda* sp. nov. and some new records for Neotropica. *Mycotaxon* 104: 309–312.
- Marques MFO, Gusmão LFP, Maia LC. 2008. Riqueza de espécies de fungos conidiais em duas áreas de Mata Atlântica no Morro da Pioneira, Serra da Jibóia, BA, Brasil. *Acta Bot. Bras.* 22(4): 954–961
- Matsushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. Kobe, Publ. by the author.
- Matsushima T. 1975. Icones microfungorum a Matsushima lectorum. Kobe, Publ. by the author.
- Matsushima T. 1980. Matsushima Mycological Memoirs No. 1. Kobe, Publ. by the author.
- Matsushima T. 1989. Matsushima Mycological Memories No. 6. Kobe, Publ. by the author.
- McLennan EI, Ducker SC, Thrower LB. 1954. New soil fungi from Australian Heathland: *Aspergillus*, *Penicillium*, *Spegazzinia*. *Australian Journal Botany* 2(3): 355–364.
- Mena-Portales J, Mercado-Sierra A. 1987. Algunos hifomicetes de las provincias Ciudad de La Habana y La Habana, Cuba. *Ecología y sistemática. Academia de Ciencias de Cuba* 17: 1–16.
- Mercado-Sierra A. 1980. Hifomicetes demaciáceos de Cuba. *Acta Botánica Cubana* 1: 1–5.
- Mercado-Sierra A. 1984. Hifomicetes demaciáceos de Sierra del Rosario, Cuba. Editorial Academia, Habana.
- Ministério da Integração Nacional. 2005. Secretaria de políticas de desenvolvimento regional. Nova delimitação do semi-árido brasileiro. Brasília: MI–SDR.
- Moreno JA. 2006. Bacias hidrográficas da Bahia. 2ª ed. Salvador: Secretaria de Meio Ambiente e Recursos Hídricos.
- Rao PR, Rao D. 1964. Some allied dematiaceae-dictyosporae from India. *Mycopatologia* 23: 23–28.
- Somrithipol S. 2007. A synnematus species of *Dictyoarthrinium* from Thailand. *Mycologia*: 99(5): 792–796.
- Subramanian CV. 1971. Hyphomycetes. Indian Coun. Agric. Res., New Delhi.
- Sutton BC. 1973. Hyphomycetes from Manitoba and Saskatchewan, Canada. *Mycol. Pap.* 132:1–143.
- Wu WP, Zhuang WY. 2005. *Sporidesmium*, *Endophragmiella* and related genera from China. *Fungal Diversity Research Series* 15: 1–351.

***Ganoderma chalceum* and *Junghuhnia meridionalis*: new records from Brazil**

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Abstract — During a survey of the polypore fungi in the Morro Santana, Porto Alegre, in southern Brazil, two species never before recorded for the country were found. *Ganoderma chalceum* has a pileate basidiome, laccate pileus surface, dimitic hyphal system, and a cuticle composed of clavate and amyloid hyphae. *Junghuhnia meridionalis* has a resupinate basidiome, dimitic hyphal system, and heavily incrustated clavate cystidia. Both species are compared with related species and illustrations are provided.

Key words — *Polyporales*, *Ganodermataceae*, *Meruliaceae*, mycodiversity

Introduction

Despite little overall knowledge of the Brazilian mycobiota, several works on polypores have recently been published, including new species and new records for Brazil (Ryvarden & Meijer 2002, Gibertoni et al. 2004, Coelho 2005, Coelho et al. 2005, 2006; Drechlsner-Santos et al. 2007, Martins Junior et al. 2008, Silva et al. 2008), indicating a growing interest in the subject on the part of Brazilian researchers.

Ganoderma P. Karst. comprises about 80 widespread species, mostly in tropical regions (Kirk et al. 2008). The genus is characterized by truncate double-walled basidiospores, with the inner wall ornamented and the outer one smooth, of a yellowish-brown color. *Amauroderma* Murrill has very similar characteristics, but it is differentiated by ovoid to ellipsoid non-truncate basidiospores (Ryvarden 1991). *G. applanatum* (Pers.) Pat. has been recorded from several regions of Brazil (Silveira & Guerrero 1991, Groposo & Loguercio-Leite 2005, Gibertoni & Cavalcanti 2003). However, according to Ryvarden (2004), this species is distributed in temperate zones, being very close to *G. australe* (Fr.) Pat., which occurs mainly in tropical zones. Other species recorded from Brazil are *G. lucidum* (Curtis) P. Karst. (Gibertoni & Cavalcanti

2003, Jesus 1996, Drechsler-Santos et al. 2008) and *G. resinaceum* Boud. (Reck & Silveira 2008, Gibertoni & Cavalcanti 2003, Groposo & Loguercio-Leite 2005), which are traditionally distinguished by the presence of stipe in the former and its absence in the latter. According to Gottlieb & Wright (1999), *G. lucidum* and *G. resinaceum* also differ in other characters, such as color of the context, reaction in the cuticle elements, and basidiospore ornamentation. Ryvar den (2000), nevertheless, considers that *G. lucidum* s. str., a species described from Europe with an almost white context, does not occur in tropical America, although many collections from the neotropics are deposited under this name in different American herbaria.

The genus *Junghuhnia* Corda contains approximately 20 species and is widespread throughout the world (Kirk et al. 2008). It is characterized by a dimitic hyphal system, small basidiospores, and large incrusted cystidia. Such microscopical characteristics are similar to those of *Steccherinum* Gray, though the latter has a hydroid hymenophore. *Antrodiella* Ryvar den & I. Johans. is also similar to *Junghuhnia*, though it lacks cystidia (Ryvar den 1991). In recent works, species recorded from different regions of Brazil include: *J. nitida* (Pers.) Ryvar den (Silveira & Guerrero 1991, Gugliotta & Capelari 1995) *J. undigera* (Berk. & M.A. Curtis) Ryvar den (Silveira & Guerrero 1991, Drechsler-Santos et al. 2008, Baltazar et al. 2009), *J. polycystidifera* (Rick) Rajchenb. (Drechsler-Santos et al. 2008, Baltazar et al. 2009) and *J. crustacea* (Jungh.) Ryvar den (Baltazar et al. 2009).

In the state of Rio Grande do Sul, southern Brazil, Morro Santana (30°03' S, 51°07' W) has an area of about 1,000 hectares with altitudes varying from 30 to 311 m above sea level. The Morro Santana region is one of the last natural remnants in the urban area of Porto Alegre, comprising great biological diversity (Mohr & Porto 1998). The climate in the region is humid subtropical of the Cfa type according to the Köppen Climate Classification (Moreno 1961). The forests are mainly located on humid slopes facing the south (Aguiar et al. 1986). According to the RADAM BRASIL classification system, this forest is a Seasonal Semideciduous Forest (Leite 2002).

Materials and methods

Specimens were collected during 2007 in the region of the Morro Santana and kept at the ICN herbarium (UFRGS). For microscopy freehand sections of the basidiomes were mounted in a drop of 5% KOH solution and 1% phloxine solution. Amyloid or dextrinoid reactions were observed using Melzer's reagent. Drawings of the microstructures were made with the assistance of a camera lucida. The codes used for colors are from the color chart by Kornerup & Wanscher (1978). The abbreviations and codes for the measurements are modified from Coelho (2005), with $Lm \times Wm$ = means of length and width,

Q = range of length/width ratios, Qm = length/width mean, and n = x/y (x = number of measurements from a given number (y) of specimens).

Taxonomy

Ganoderma chalceum (Cooke) Steyaert

Bull. Jard. bot. natn. Belg. 37: 481, 1967.

FIGS 1–2, 5

BASIDIOMATA perennial, pileate, sessile, dimidiate, semi-circular, corky to woody, 7 cm diam. and up to 2 cm thick; upper surface laccate, sulcate, glabrous, with a distinct cuticle in section, reddish-brown (9F5 – 9F8) with a lighter margin (8C3); pore surface beige (4C3) to pale brown (6D4), pores angular to circular, 3–5 per mm; tubes with thick dissepiments, pale brown (6D4–6E4), up to 3 mm deep; context brown (6E6–6F6) in section with a black resinous band starting at the base and extending almost to the margin.

HYPHAL SYSTEM dimitic. Generative hyphae with clamps, thin-walled, hyaline, 1.5–3.0 µm diam.; skeletal hyphae abundant, unbranched or sparingly branched, thick-walled, yellowish-brown, 2.0–7.0 µm diam.; n = 30/1. Cuticle with cylindrical to club-shaped hyphae, thick-walled, apically strongly amyloid. Basidia clavate, 4-sterigmate, hard to observe; basidiospores ellipsoid to narrowly ellipsoid, truncate, yellowish-brown, double-walled, inner wall verrucose and outer wall smooth, 9.5–11.5 × 6.0–7.0 µm, Lm × Wm = 10.4 × 6.5, Q = 1.4 – 1.9, Qm = 1.7, n = 30/1.

CULTURE DESCRIPTION: Unknown

SUBSTRATA: On dead hardwoods.

DISTRIBUTION: According to Ryvar den (2004) widespread in the paleotropical zone and known in the neotropical zone only from Colombia as *G. hollidayi* Steyaert (= *G. chalceum*).

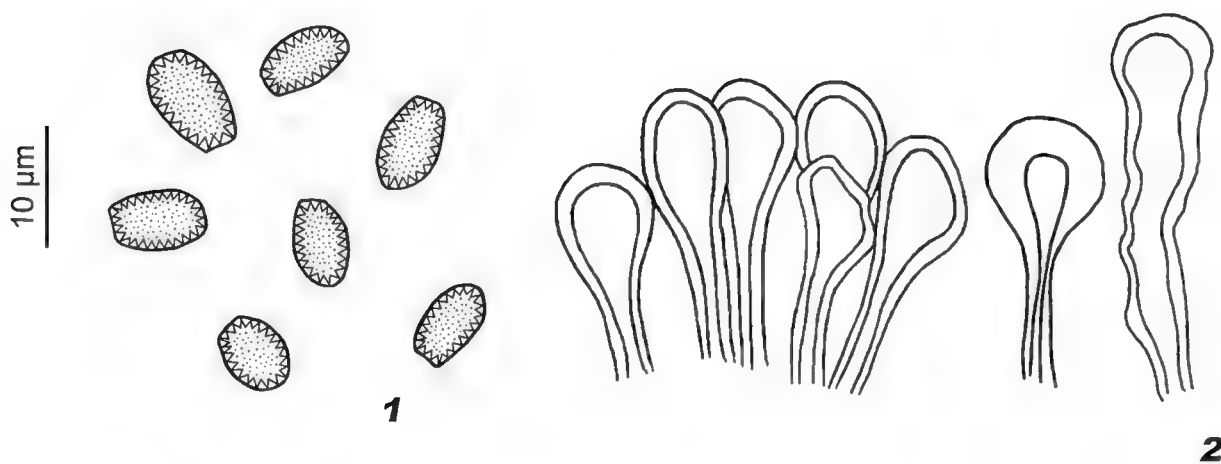


FIG. 1–2. Microscopic characters of *Ganoderma chalceum* (ICN 154096):

1. Basidiospores. 2. Cuticle hyphae

SPECIMEN EXAMINED: BRAZIL. Rio Grande do Sul State, municipality of Porto Alegre, Morro Santana, 11.V.2007, leg. M.C. Westphalen 043/07 (ICN 154096).

ADDITIONAL SPECIMENS EXAMINED: PANAMA. Santa Cruz, Parque Nacional Coiba, 17.XI.1996, leg. M. Nuñez 1124 (O 913359); UGANDA. Sesse Island, leg. Maitland s/n (O 918172); ZAMBIA. Ndola, 22.III.1982, leg. G.D. Pierce 715/2-3 (O 918173); BELIZE. Cayo, Blue Hole National Park, 15.XI.2001, leg. Leif Ryvar den 44192 (O 17638 *Ganoderma stipitatum*); COSTA RICA. Bijagua, Tilaran, Parque Nacional Volcan Tenorio, 16.VII.2001, leg. Leif Ryvar den 43820 (O 18649 *Ganoderma stipitatum*); ECUADOR. Orellana, Yasuni National Park, 9-12.III.2002, leg. Leif Ryvar den 44573 (O 110173539 *Ganoderma elegantum* HOLOTYPE).

REMARKS: *Ganoderma chalceum* is included in the *G. resinaceum* complex (Ryvarden 2004) and is characterized by the laccate upper surface, the lack of a stipe, the presence of a black resinous band in the context, and the amyloid cuticle. According to Ryvarden (2004), this species has a slightly amyloid reaction in the cuticle; however our material has a strongly amyloid reaction in this part. This species is very similar to *G. resinaceum*, differing only by the presence of a black band in the context. *Ganoderma stipitatum* Murrill (Murrill) and *G. elegantum* Ryvarden are other species with black bands in the context and a cuticle with cylindrical to club-shaped elements; however the former has smaller basidiospores ($7.0\text{--}9.5 \times 5.0\text{--}6.5 \mu\text{m}$), and the latter has a long thin stipe and smaller pores (6–7 per mm)

Junghuhnia meridionalis (Rajchenb.) Rajchenb.

Aust. Syst. Bot. 16(4): 477, 2003.

FIGS 3–4, 6

BASIDIOMATA annual, resupinate, very thin, soft when fresh, fragile and brittle when dried; pore surface dull red when fresh (8C3), becoming reddish-brown (8D4) when dried, pores regular, round to angular, 5–9 per mm; tubes concolorous with pore surface, up to 0.5 mm deep; subiculum concolorous with pore surface, up to 0.1 mm thick.

HYPHAL SYSTEM dimitic. Generative hyphae clamped, hyaline, thin-walled to slightly thick-walled, $2.0\text{--}4.0 \mu\text{m}$ wide; skeletal hyphae thick-walled, dominant in the trama and subiculum, $2.0\text{--}4.0 \mu\text{m}$ wide, hyaline to yellowish; $n=20/1$. Skeletocystidia abundant, embedded in the trama or projecting up to $40.0 \mu\text{m}$ above the hymenium, clavate, thick-walled, heavily incrusted, $8.0\text{--}14.0 \mu\text{m}$ diam.; fusoid cystidioles present. Basidia clavate, 4-sterigmate; basidiospores narrowly ellipsoid to ellipsoid, hyaline, smooth and thin-walled, $3.0\text{--}4.0 \times 1.5\text{--}2.0 \mu\text{m}$, $Lm \times Wm = 3.6 \times 1.9$, $Q = 1.5 - 2.0$, $Qm = 1.9$, $n = 20/1$.

CULTURE DESCRIPTION: see Rajchenberg (2003).

HABITAT: On dead hardwoods, associated with a white rot.

DISTRIBUTION: According to Rajchenberg (2006) this species has an austral distribution, occurring in New Zealand, Argentina, and Chile.

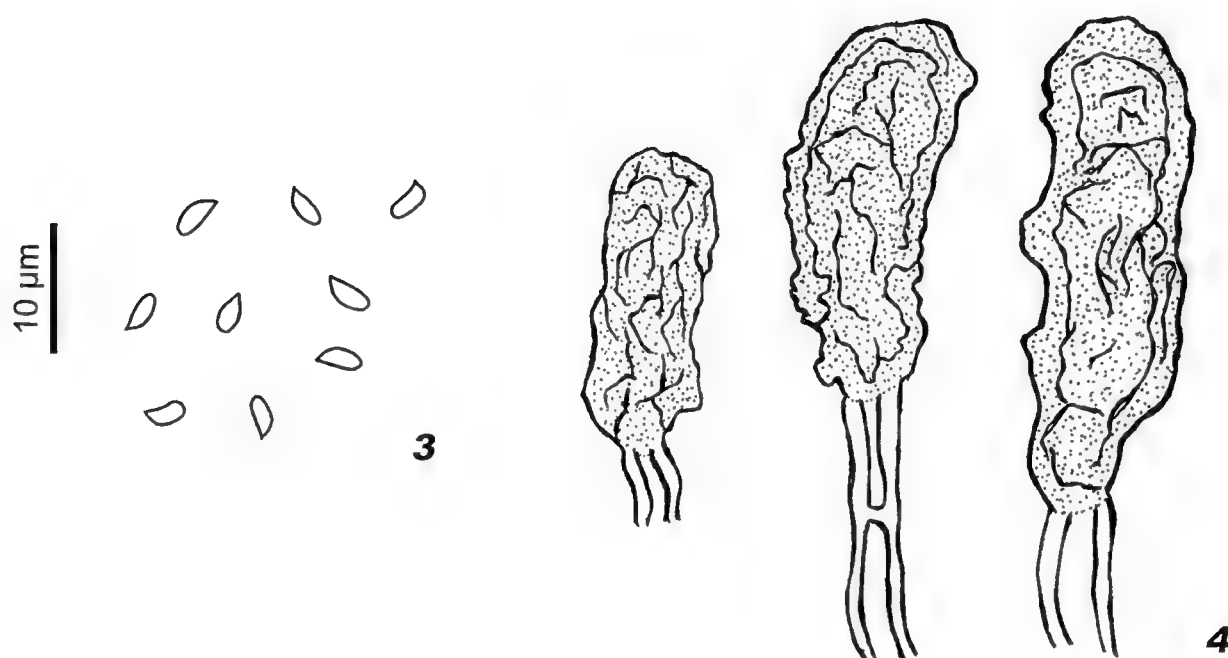


FIG. 3–4. Microscopic characters of *Junghuhnia meridionalis* (ICN 154079):
3. Basidiospores. 4. Cystidia

SPECIMEN EXAMINED: BRAZIL. Rio Grande do Sul State, municipality of Porto Alegre, Morro Santana, 04.V.2007, leg. M.C. Westphalen 025/07 (ICN 154079).

ADDITIONAL SPECIMENS EXAMINED: ARGENTINA. Neuquén, Quetrihué, 16.V.1952, leg. R. Singer M-650 (BAFC 27996); Parque Nacional Lanín, Cascada Chacín, 19.V.1999, leg. M. Rajchenberg 11924 (CIEFAP); BRAZIL. Rio Grande do Sul, municipality of São Francisco de Paula, FLONA-SFP, 22.VI.2009, leg. M.C. Westphalen 238/09 (ICN 154290); municipality of Derrubadas, Parque Estadual do Turvo, 15.IX.2009, leg. M.A. Reck 198/09 (ICN 154340); CHILE. Prov. Palena, Chaitén, 06.IV.1996, leg. M. Rajchenberg 11086 (CIEFAP); CZECHOSLOVAKIA. Moravia, Vysoká, 08.VII.1989, leg. P. Vampola s/n (BAFC 32625 *Junghuhnia nitida*); YUGOSLAVIA. Corkola uvala, 21.X.1983, leg. M. Tortic s/n (BAFC 30988 *Junghuhnia collabens*).

REMARKS: *Junghuhnia meridionalis* is a beautiful resupinate species that is characterized by the pinkish to cinnamon pore surface and the waxy soft consistency when fresh, becoming brittle upon drying. This species was first described as a variety of *J. collabens* (Fr.) Ryvarden (Rajchenberg 1988), but recently, using cultural and reproductive characteristics, Rajchenberg (2003) verified that *J. meridionalis* is an autonomous taxon. Our specimen fits the description given by Rajchenberg (1987), except for a small difference in pore size (5–9 pores/mm in our material, 6–8/mm in Rajchenberg's specimens). *Junghuhnia nitida* is a similar species that can have a cream to pink cinnamon colored hymenophore but differs microscopically in wider, broadly ellipsoid to ovoid, basidiospores ($4.0\text{--}4.5 \times 2.0\text{--}3.0 \mu\text{m}$). *Junghuhnia collabens* is also a similar species, but it is darker brick-red to cocoa-brown, has larger pores 3–4/mm, and cylindric-allantoid basidiospores ($3.5\text{--}5.0 \times 1.0\text{--}2.0 \mu\text{m}$); according to Rajchenberg (2003) this species grows mainly on conifers.



FIG. 5-6. Basidiomes.
5. *Ganoderma chalceum*.
6. *Junghuhnia meridionalis*.
Scale bar = 1 cm.

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Literature cited

- Aguiar LW, Martau L, Soares ZF, Bueno OL, Mariath JE, Klein RM. 1986. Estudo preliminar da flora e vegetação dos morros graníticos da Região de Grande Porto Alegre, Rio Grande do Sul, Brasil. *Iheringia, Série Botânica* 34: 3–34.
- Baltazar JM, Trierveiler-Pereira L, Loguercio-Leite, C. 2009. A checklist of xylophilous basidiomycetes (*Basidiomycota*) in mangroves. *Mycotaxon* 107: 221–224.
- Coelho G. 2005. A Brazilian new species of *Auriporia*. *Mycologia* 97: 266–270.
- Coelho G, Reck MA, Silveira RMB, Guerrero RT. 2005. *Ceriporia spissa* (Schwein. ex Fr.) Rajchenb. (*Basidiomycota*): first records from Brazil. *Biociências* 13(2): 107–111.
- Coelho G, Silveira RMB, Rajchenberg M. 2006. A new *Gloeoporus* species growing on bamboo from southern Brazil. *Mycologia* 98(5): 821–827.
- Drechsler-Santos ER, Vasconcellos-Neto JRT, Gibertoni TB, Góes-Neto A, Cavalcanti MAQ. 2007. Notes on *Navisporus*: *N. terrestris* and *N. floccosus* from Brazil. *Mycotaxon* 101: 265–269.
- Drechsler-Santos ER, Groposo C, Loguercio-Leite C. 2008. Additions to the knowledge of lignocellulolytic basidiomycetes in forests from Santa Catarina, Southern Brazil. *Mycotaxon* 103:197–200.
- Gibertoni TB, Cavalcanti MAQ. 2003. A mycological survey of the *Aphylllophorales* (*Basidiomycotina*) of the Atlantic Rain Forest in the State of Pernambuco, Brazil. *Mycotaxon* 87: 203–211.
- Gibertoni TB, Ryvardeen L, Cavalcanti MAQ. 2004. Studies in neotropical polypores 18. New species (*Basidiomycota*) from Brazil. *Synopsis Fungorum* 18: 44–56.
- Gugliotta AM, Capelari M. 1995. *Polyporaceae* from Ilha do Cardoso, SP, Brazil. *Mycotaxon* 61: 107–113.
- Gottlieb AM, Wright JE. 1999. Taxonomy of *Ganoderma* from southern South America: subgenus *Ganoderma*. *Mycological Research* 103(6): 661–673.
- Groposo C, Loguercio-Leite C. 2005. Contribution to the lignocellulolytic fungi (*Basidiomycetes*) of the Atlantic Rain Forest in Southern Brazil. *Mycotaxon* 92: 103–106
- Jesus MA. 1996. Contribution to the knowledge of wood-rotting fungi in Brazil. II. Checklist of fungi from Maracá Island, Roraima State. *Mycotaxon* 57: 323–328.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2008. *Ainsworth and Bisby's Dictionary of the fungi*. 10th Edition, CABI Publishing. 771p.
- Kornerup A, Wanscher JH. 1978. *Methuen handbook of colour*. 3rd ed. London (UK): Eyre Methuen.
- Leite PF. 2002. Contribuição ao conhecimento Fitoecológico do Sul do Brasil In: *Fitogeografia do Sul da América*. *Ciência & Ambiente* 24: 51–73.
- Martins Junior AS, Gibertoni TB, Sótão HMP. 2008. *Diplomitoporus allantosporus* (*Basidiomycetes*): a new record to Brazil. *Mycotaxon* 106: 195–198.
- Mohr FV, Porto ML. 1998. Morro Santana: o verde luxuriante nas encostas íngremes. In: Menegat R, Porto ML, Carraro CC, Fernandes LAD (Coords.). *Atlas Ambiental de Porto Alegre*. Porto Alegre: Editora da UFRGS. 228 p.

- Moreno JA. 1961. Clima do Rio Grande do Sul. Secretaria da Agricultura do Rio Grande do Sul. Porto Alegre.
- Rajchenberg M. 1988 ('1987'). Xylophilous *Aphylllophorales* (*Basidiomycetes*) from the southern Andean forests. Additions and corrections. II. Sydowia 40: 235–249.
- Rajchenberg M. 2003. Taxonomic studies on selected Austral polypores, Austral. Syst. Bot. 16: 473–485.
- Rajchenberg M. 2006. Los Políporos (*Basidiomycetes*) de los Bosques Andino Patagónicos de Argentina. Biblioteca Mycologica 201: 1–300.
- Reck MA, Silveira RMB. 2008. Ordem *Polyporales* (*Basidiomycota*) no Parque Estadual de Itapuã, Viamão, Rio Grande do Sul. Revista Brasileira de Biociências 6(3): 301–314.
- Ryvarden L. 1991. Genera of Polypores: Nomenclature and taxonomy. Synopsis Fungorum 5: 1–363.
- Ryvarden L. 2000. Studies in neotropical polypores 2: a preliminary key to neotropical species of *Ganoderma* with a laccate pileus. Mycologia 92(1): 180–191.
- Ryvarden L. 2004. Neotropical polypores Part 1. Introduction, *Ganodermataceae* & *Hymenochaetaceae*. Synopsis Fungorum 19: 1–229.
- Ryvarden L, Meijer AAR. 2002. Studies in neotropical polypores 14. New species from the state of Paraná, Brazil. Synopsis Fungorum 15: 34–69.
- Silva ACG, Ryvarden L, Gibertoni TB. 2008. *Coltricia fragilissima*, a new record for Brazil. Mycotaxon 105: 469–472.
- Silveira RMB, Guerrero RT. 1991. *Aphylllophorales* poliporóides (*Basidiomycetes*) do Parque Nacional de Aparados da Serra, RS. Boletim do Instituto de Biociências 48:1–147.

New records of *Loculoascomycetes* from natural protected areas in Sonora, Mexico

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Abstract — Thirty collections of *Loculoascomycetes* from the Ajos-Bavispe National Forest Reserve and Wildlife Refuge, the Pinacate and Great Altar Desert Biosphere Reserve, and the Sierra of Alamos-Rio Cuchujaqui Biosphere Reserve, in Sonora, Mexico were studied. Ten new records for the Mexican mycobiota are presented: *Capronia montana*, *Chaetoplea crossata*, *Didymosphaeria futilis*, *Glonium abbreviatum*, *Hysterographium mori*, *Montagnula infernalis*, *Patellaria atrata*, *Rhytidhysterium rufulum*, *Thyridaria macrostomoides*, and *Valsaria rubricosa*. Photographs of macro- and microscopic characters are given for some species.

Key words: *Chaetothyriales*, *Hysteriales*, *Melanommatales*, *Patellariales*, *Pleosporales*

Introduction

The term *Loculoascomycetes* is used for ascomycetes with bitunicate asci and septate ascospores (Kirk et al. 2008). There is some controversy over the taxonomy of the genera in this group, e.g., *Valsaria*, because authors such as Dennis (1978) have placed them in the *Loculoascomycetes* owing to their bitunicate asci while others, such as Barr (1990a), have included them in *Pyrenomyces* arguing the presence of unitunicate asci. Boehm et al. (2009) studied four nuclear genes in different species of *Loculoascomycetes* and have proposed changes to the current taxonomy, e.g., *Rhytidhysterium rufulum* which was previously included in order *Patellariales* has been tentatively moved to the *Hysteriales*. Thus, *Patellaria atrata*, included in the present study on the mycobiota of Sonora, because of its nearness to *R. rufulum*, might also belong

in the *Hysteriales*. As such, future genetic studies to compare and define the taxonomic concepts of these species are recommended.

The ecological importance of these saprophytic fungi is highlighted by their ability to degrade cellulose. They therefore break down organic matter and carry out one of the most important ecological functions, guaranteeing that organic matter is recycled in the ecosystem (Chapin et al. 2002). According to Méndez-Mayboca et al. (2007, 2008), 105 species of *Ascomycetes* have been recorded for Sonora. Of these, 14 are *Loculoascomycetes*, representing 20% of that reported for the Mexican mycobiota. With the 10 new records described in the present study, the current catalog of *Loculoascomycetes* will be comprised of 24 and 80 species for Sonora and Mexico respectively.

Material and methods

Thirty collections of *Loculoascomycetes* from the macromycetes collection of the Centro de Estudios Superiores del Estado de Sonora (CESUES), with some duplicates in the herbarium of the Instituto de Ecología A.C. (XAL) in Xalapa, Veracruz were identified. Specimens were collected in the following protected natural areas of Sonora: the Pinacate and Great Altar Desert Biosphere Reserve, the Sierra of Alamos-Rio Cuchujaqui Biosphere Reserve, and the Ajos-Bavispe National Forest Reserve and Wildlife Refuge.

Specimens were studied following the conventional mycology techniques given by Dennis (1978) and by Breitenbach & Kränzlin (1984), and were identified using specific literature such as the contributions of Scheinpflug (1958), Chesters & Bell (1970), Luttrell (1973), Barr (1978, 1990a,b, 1991), Glawe (1985), Bellemère et al. (1986), Holm & Holm (1988), Aptroot (1995), Ju et al. (1996), Vasilyeva (2000), Delgado-Rodríguez & Checa (2002) and Checa et al. (2007) among others.

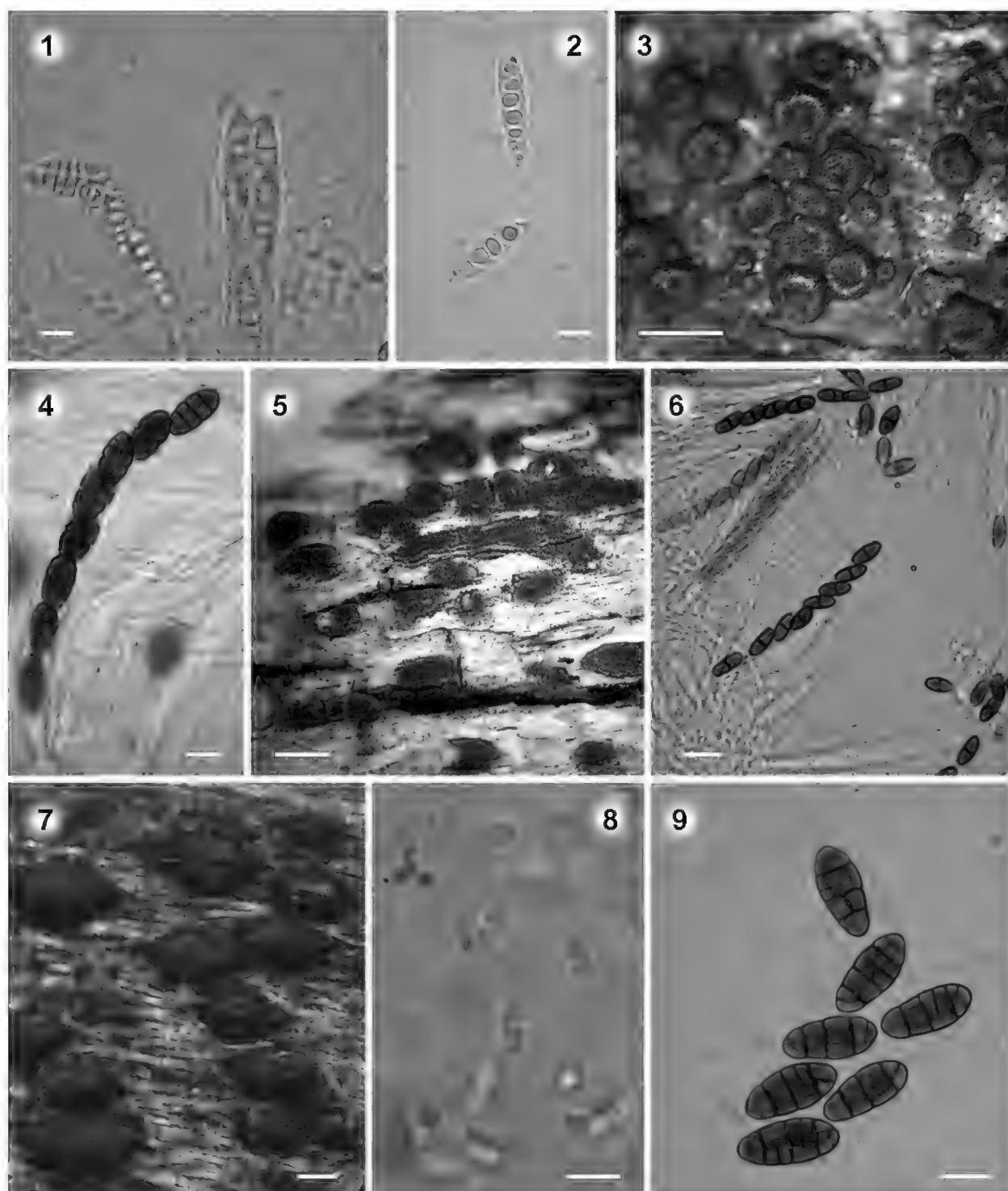
Species studied

Capronia montana M.E. Barr, Mycotaxon 41(2): 430 (1991) FIGURES 1–2

Pseudothecia 0.1–0.3 mm diam., black, superficial, globose, gregarious, located on hyphae that form a blackish crust at the edge, centrally depressed with a small papilla, outer surface with setae of $20\text{--}45 \times 4\text{--}6 \mu\text{m}$, sharp, thick and dark; black, thin subiculum at the base. Asci $75\text{--}85 \times 12\text{--}14 \mu\text{m}$, bitunicate, claviform, with 8 spores irregularly biserial, with a broad ocular chamber $9\text{--}13 \mu\text{m}$ long. Ascospores $19\text{--}23 \times 5\text{--}6 \mu\text{m}$, fusoid, hyaline when immature, brown when mature, with 5 transverse septa, with terminal cells obtuse, wall smooth. Pseudoparaphyses absent.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Cumpas, EL MEZQUITAL ($109^{\circ}38'23''$ W $29^{\circ}57'26''$ N)—in mesquite vegetation on the fallen branches of *Prosopis* sp. Leg. A. Sánchez. 02.XII.2004 CESUES 5381.

OBSERVATIONS — The genus *Capronia* Sacc. is characterized by its spherical or globose ascoma, centrally depressed and with a small papilla, as well as by



FIGS. 1–9. *Loculoascomycetes* of Sonora, Mexico. 1–2: *Capronia montana*. 1. Asci. 2. Ascospores fusoid. 3–4: *Chaetoplea crossata*. 3. Pseudothecia. 4. Ascospores ellipsoid. 5–6: *Didymosphaeria futilis*. 5. Pseudothecia. 6. Ascospores ellipsoid. 7–8: *Glonium abbreviatum*. 7. Hysterothecia. 8. Ascospores fusiform. 9: *Hysterographium mori*. Ascospores muriform.

Scale bar: 1, 2, 8 = 5µm; 4, 6, 9 = 10µm; 3 = 0.5 mm; 5 = 3 mm; 7 = 1 mm.

the presence of long, dark setae (Barr 1991). Although the hymenium of the material studied was not completely developed, the morphology of the ascoma and spore agreed with the description of *C. montana* made by Barr (1991).

Chaetoplea crossata (Ellis & Everh.) M.E. Barr, Mem. N. Y. Bot. Gdn. 62: 50 (1990)

FIGURES 3–4

Pseudothecia 0.2–0.5 mm diam., black, globose, centrally depressed, with a small papilla, gregarious with a black, thin subiculum at the base. Asci $120\text{--}160 \times 10\text{--}17\text{ }\mu\text{m}$, bitunicate, with a short stipe, cylindrical, with 8 spores, uniseriate. Ascospores $14\text{--}22 \times 8.5\text{--}11\text{ }\mu\text{m}$, ellipsoid, muriform, olivaceous-brown, with 3 slightly constricted transverse septa, with 1(–3) discontinuous longitudinal septum; the cells at the edges have bifurcate septa, wall smooth. Pseudoparaphyses $1.5\text{--}2\text{ }\mu\text{m}$ diam.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Cumpas, EL MEZQUITAL ($109^{\circ}38'23''\text{ W } 29^{\circ}57'26''\text{ N}$)—in mesquite vegetation. Leg. A. Sánchez. 27.VIII.2005 CESUES 6325.

OBSERVATIONS — The genus *Chaetoplea* (Sacc.) Clem. is characterized by spherical or globose ascomata, centrally depressed and with a small papilla (Barr 1990b). Owing to its spore morphology, *C. crossata* has been included in this genus. *Pleospora calvescens* (Fr. ex Desm.) Tul. & C. Tul. is similar to *C. crossata*, but can be differentiated by its narrower spores (5–)6–8(–9) μm and occasionally without longitudinal septa. The spore width of the material studied is $8.5\text{--}11\text{ }\mu\text{m}$ and spores are muriform, characteristics which coincide with Barr's (1990b) description of *C. crossata*; this author also notes that this species has the largest spores in the genus.

Didymosphaeria futilis (Berk. & Broome) Rehm, Hedwigia 18: 167 (1879)

FIGURES 5–6

Pseudothecia 0.5–5 mm diam., black, semi-immersed to superficial, covered by a clypeus which extends across the substrate forming a blackish surrounding layer, globose, with a small ostiolar papilla, solitary to mostly gregarious. Asci $68\text{--}75 \times 7\text{--}8\text{ }\mu\text{m}$, bitunicate, cylindrical, octosporous, uniseriate. Ascospores $8\text{--}12 \times 3\text{--}5\text{ }\mu\text{m}$, ellipsoid, brown, with a transverse septum, occasionally the wall is covered with a gelatinous sheath. Trabecular pseudoparaphyses $1\text{ }\mu\text{m}$ diam.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Puerto Peñasco, SIERRA LOS TANQUES ($113^{\circ}20'13''\text{ W } 31^{\circ}50'01''\text{ N}$)—sarcocaulis scrub vegetation. Leg. A. Sánchez, I. Encinas, J. Miranda. 06.XI.2003 CESUES 5041.

OBSERVATIONS — Aptroot (1995) published a monograph of the genus *Didymosphaeria* Fuckel with seven species. This genus is characterized by ascoma immersed in the substrate, globose, ascospores brown and bicellular. *Didymosphaeria futilis* has been included in this genus because of its spore morphology (Luttrell 1973). Although it is a cosmopolitan species that grows on a wide variety of substrates, its morphology is uniform with the exception

of spore size, which is always less than 13 μm in length (Aptroot 1995). The material studied coincides with the descriptions given by Scheinpflug (1958) and Aptroot (1995).

Glonium abbreviatum (Schwein.) L.M. Lohman, Bull. Torrey Bot. Club 64: 64 (1937)

FIGURES 7–8

Hysterothecia 0.2–0.9 \times 0.1–0.2 mm, black, carbonaceous, elongated, oval to linear, erumpent, gregarious. Peridium composed of pseudoparenchymatous cells. Asci 35–40 \times 4–6 μm , cylindrical-claviform, with 8 irregularly biseriate spores. Ascospores 5–7 \times 2.5–3 μm , fusiform, hyaline, with a slightly constricted median septum, smooth wall. Cellular pseudoparaphyses.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Álamos EL PLATANAR (108°40'40.4" W 26°59'26.7" N)—tropical deciduous forest. Leg. S. Chacón. 15.IX.2006 CESUES 5764.

OBSERVATIONS — The genus *Glonium* Muhl. is characterized by hyaline, bicellular spores (Zogg 1962), while *G. abbreviatum* can be distinguished from the other species in the genus by its spore morphology. The main characters of the material studied coincide with the descriptions of Zogg (1962) and Vasilyeva (2000). According to these authors, the distinguishing character of this species is that it has the smallest spores of the genus.

Hysterographium mori (Schwein.) Rehm, Ascomyceten: no. 363 (1876) FIGURE 9

Hysterothecia 0.4–1.2 \times 0.2–0.3 mm, black, elongated, linear, erumpent, gregarious, with lines parallel to the longitudinal opening slit. Peridium composed of pseudoparenchymatous cells 4–14 \times 3–9 μm , with external cells darker and more sclerotic. Asci 92–130 \times (13–)14–16(–18) μm , cylindrical-claviform, with 8 irregularly biseriate spores. Ascospores (16–)17–24 \times 6–10 μm , ellipsoid to fusiform, brown, muriform, with 3(–5) transverse septa and 1(–3) longitudinal septa, slightly constricted at the median septum, wall smooth. Cellular pseudoparaphyses 1 μm diam., hyaline.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Álamos HUERTA VIEJA (109°02'53.0" W 27°02'5.4" N)—tropical deciduous forest. Leg. S. Chacón. 14.IX.2006 CESUES 5736, CESUES 5801.

OBSERVATIONS — This taxon can be distinguished from the other species in the genus by its spore morphology. The main characters of the material studied coincide with the descriptions of Zogg (1962), Dennis (1978), Barr (1990b) and Linde (1992). Although the asci are cylindrical-claviform, and the arrangement of the spores is biseriate, some authors such as Delgado-Rodríguez & Checa (2002) and Zogg (1962) have described the asci as cylindrical since this species exhibits much variability in its spore morphology, depending on substrate type and environmental conditions (Linde 1992).

Montagnula infernalis (Niessl) Berl., Icon. Fung. (Abellini) 2: 68 (1896)

FIGURES 10–11

Pseudothecia 0.1–0.3 mm diam., black, globose, carbonaceous, solitary to gregarious, immersed, erumpent to superficial, covered by a clypeus. Asci 95–121 × 17–22 µm, claviform, bitunicate, with 8 biseriate spores, occasionally uniseriate. Ascospores 18–22 × 8–11 µm, ellipsoid, muriform, brown, with 3 transverse septa and the middle one constricted; with 1(–2) discontinuous longitudinal septa, which on rare occasions reach one of the extreme cells of the spore, wall subverrucose, surrounded by a gelatinous sheath. Cellular pseudoparaphyses 2–3 µm diam., hyaline.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Puerto Peñasco SIERRA BLANCA (113°25'40" W 31°31'55" N)—in microphyllous desert scrub. Leg. S. Chacón. 15.IX.2006 CESUES 5092.

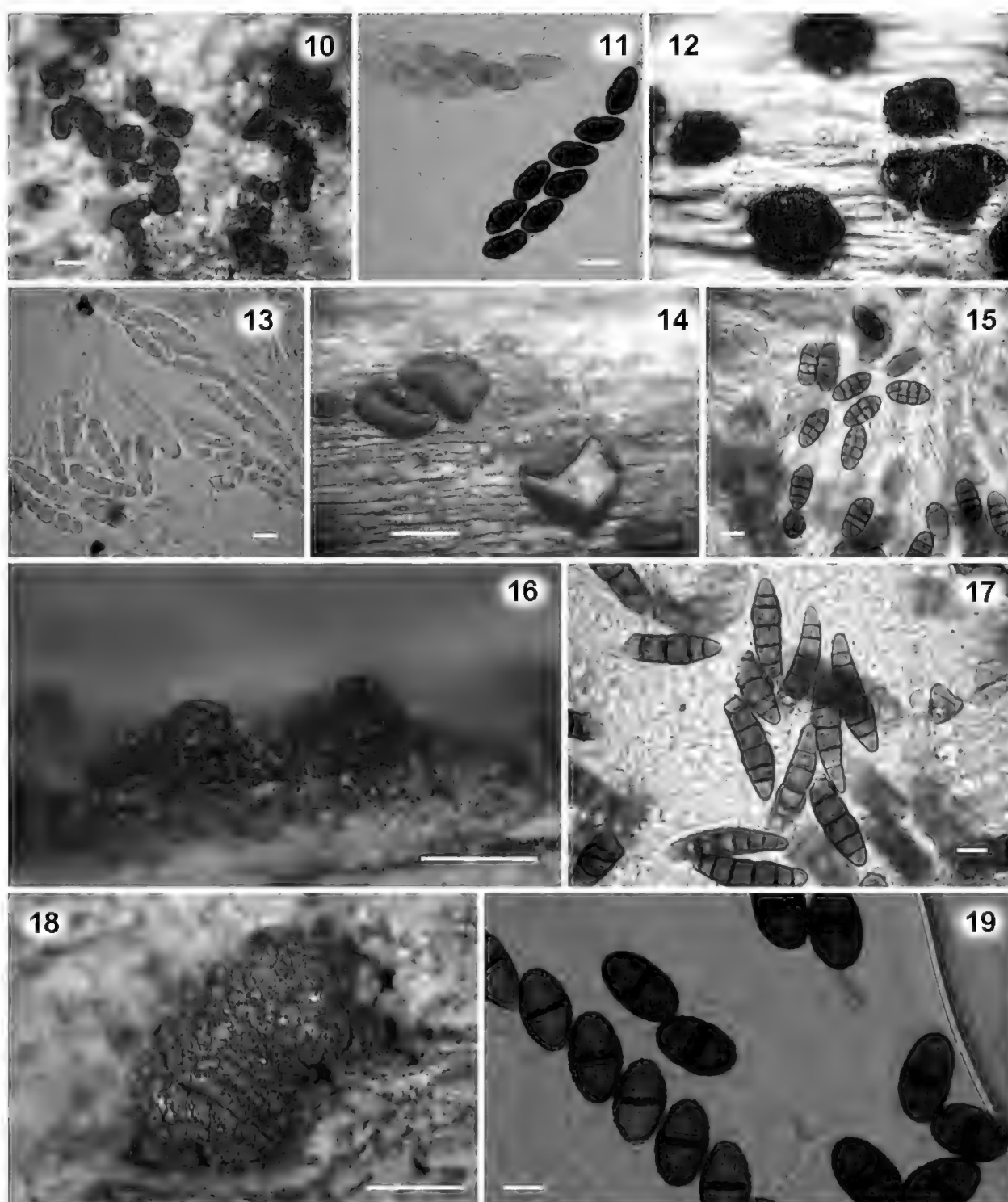
OBSERVATIONS — The genus *Montagnula* Berl. is characterized by its ascomata immersed in the substrate, with clypeus, globose or spherical; claviform asci; pseudoparaphyses narrow and cellular; ascospores fusoid or ellipsoid, with transverse septa and one or more longitudinal septa (Barr 1990b). It is a genus characteristic of the monocots with a long stem. Owing to its ascospores which measure 20–23(–30) × 7–10 µm, with 3 transverse septa, the material studied coincides with *M. infernalis* described by Barr (1990b).

Patellaria atrata (Hedw.) Fr., Syst. Mycol. (Lundae) 2: 160 (1822) FIGURES 12–13

Apothecia 0.5–1 mm diam., solitary or in groups of up to three ascomata, immersed and closed at first, later they open via a longitudinal pore forming a disc, black, superficial or occasionally immersed, sessile, circular or slightly elongated, carbonaceous, black excipulum. Asci 50–83 × 13–19 µm, cylindrical-claviform, short stipe, bitunicate with 6 to 8 spores. Ascospores 20–27 × 6–8 µm, claviform, hyaline, with 4–5 transverse septa, regularly biseriate. In the immature ascoma, the hamathecium forms the paraphysoids and in the mature, open ascomata, gives rise to the paraphyses, which are hyaline, 1.5–2 µm diam.; the epithecium reacts with KOH 5% becoming blue-green.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Puerto Peñasco, CRÁTER EL ELEGANTE (113°22'55" W 31°51'34" N)—in sarcocaulle scrub. Leg. A. Sánchez. 17.I.2004 CESUES 5130.

OBSERVATIONS — The genus *Patellaria* Fr. is characterized by hyaline spores and more than one septum (up to more than 5) (Kutorga & Hawksworth 1997). *Patellaria atrata* is distinguished from the other species in this genus by its claviform spore morphology. The main characters of the material studied coincide with the descriptions of Kutorga & Hawksworth (1997), who also highlight for this species apothecium surface black and epithecium dark



FIGS. 10–19. *Loculoascomycetes* of Sonora, Mexico. 10–11: *Montagnula infernalis*. 10. Pseudothecia. 11. Ascospores ellipsoid to muriform. 12–13: *Patellaria atrata*. 12. Apothecia. 13. Ascospores claviform. 14–15: *Rhytidhysterium rufulum*. 14. Apothecia. 15. Ascospores ellipsoid to fusiform. 16–17: *Thyridaria macrostomoides*. 16. Pseudothecia. 17. Ascospores subfusoid. 18–19: *Valsaria rubricosa*. 18. Stroma hypoxylid. 19. Ascospores ellipsoid.

Scale bar: 10, 16 = 0.5 mm; 11, 13, 15, 17 = 10 μ m; 12 = 0.1 mm; 14, 18 = 1 mm; 19 = 5 μ m.

green. Bellemère et al. (1986) observed that the hamathecium has paraphysoid filaments when the ascoma is young and filaments that are similar to mature paraphyses; observations which concur perfectly with the material studied.

Rhytidhysterium rufulum (Spreng.) Speg., Bol. Acad. Nac. Ci. 25: 79 (1921)

FIGURES 14–15

Apothecia $1\text{--}2.2 \times 0.5\text{--}1.5$ mm, solitary to gregarious, erumpent; black when young, linear, elongated, carbonaceous; when mature the fruiting bodies have a disc that is typical in appearance with irregular margins, black to dark brown; epithecium black, dark brown, red or yellow; when they age the margins curl upwards and the ascoma takes the shape of a hysterothecium with cracked lips that are very characteristic. Asci $139\text{--}190 \times 12\text{--}17$ μm , bitunicate, with a short stipe, cylindrical, with 8 uniseriate spores. Ascospores $23\text{--}31 \times 8\text{--}12$ μm , ellipsoid to fusiform, brown, with 1–3 transverse septa, under the light microscope the edges appear with a lighter colored area where the spore germinates, without actually forming germination pores, smooth. Cellular paraphyses 2–6 μm diam. Epithecium amyloid and turns violet with potassium hydroxide 5%.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Álamos PROMONTORIOS ($109^{\circ}02'10.5''$ W $27^{\circ}00'54.1''$ N)—in tropical deciduous forest. Leg. A. Sánchez. 14.IX.2006 CESUES 5711, 5712, 5730, 5812.

OBSERVATIONS — The characteristics that identify the genus *Rhytidhysterium* Speg. are mainly the shape of the fruiting body and spore morphology (Samuels & Müller 1979). The immature ascoma is elongated in shape (lirelliform) with grooves; on maturing it opens along a central longitudinal line, forming an apothecium and finally under dry conditions the margin of the discs collapses becoming hysteriform, triangular or tri-radiate (Kutorga & Hawksworth 1997). Based on these characteristics, and ascospores with 3 transverse septa, the material agrees with *R. rufulum*. Although Samuels & Müller (1979) mention narrower spores $3.5\text{--}4.5\text{--}6.5$ μm , the observed measurements coincide with those given by Kutorga & Hawksworth (1997): $(22\text{--})25\text{--}35\text{--}(39) \times (7.5\text{--})9\text{--}12\text{--}(14)$ μm . A related species is *R. hysterinum* (Dufour) Samuels & E. Müll., but its spores have a single transverse septum (Kutorga & Hawksworth 1997).

Thyridaria macrostomoides (De Not.) M.E. Barr, N. Amer. Fl., Ser. 2 (New York)

13: 34 (1990)

FIGURES 16–17

Pseudothecia 0.5–1.2 mm, black, solitary, immersed or semi-immersed, covered with a dark layer similar to the clypeus that extends over the substrate; ostiole laterally compressed. Peridium formed by several layers, composed of pseudoparenchymatous cells $7\text{--}12 \times 3\text{--}5$ μm . Asci $145\text{--}165 \times 20\text{--}22$ μm , bitunicate, claviform, with 8 biseriate spores. Ascospores $29\text{--}45 \times 10\text{--}12$ μm , subfusoid, first formed septum supramedian, dark with subhyaline terminal cells, with $(3\text{--})4\text{--}6\text{--}(8)$ transverse septa, smooth. Pseudoparaphyses trabecular.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Puerto Peñasco, CRÁTER EL ELEGANTE ($113^{\circ}22'55''$ W $31^{\circ}51'34''$ N)—in sarcocaul scrub. Leg. A. Sánchez. 08.XI.2003 CESUES 5077, 5078, 5079.

OBSERVATIONS — This species is delimited by the morphology, size and number of septa of its spores. Owing to its laterally compressed ostiole it was previously included in the genus *Lophiostoma*, family *Lophiostomataceae* (Chesters & Bell 1970, Holm & Holm 1988). Barr (1990a) placed it in genus *Thyridaria* Sacc. in family *Platystomataceae*, indicating that the ostiole can be rounded or compressed and the distribution of the ascoma in valsoid groups or the presence of the clypeus or can have colored hyphae on them. These characteristics were observed on the material studied.

Valsaria rubricosa (Fr.) Sacc., Syll. Fung. (Abellini) 1: 743 (1882) FIGURES 18–19

Stroma 0.5–0.8 × 3–4 mm diam., hypoxylous appearance, pigmented red-orange and surface spotted with black owing to the ostioles of the abundant superficial perithecia. Asci 90–108 × 10–14 µm, bitunicate, cylindrical, with 8 uniseriate spores. Ascospores 12–16 × 6–9 µm, ellipsoid, with a transverse median septum, ornamented wall, covered by gelatinous sheath. Pseudoparaphyses trabecular 3–4 µm diam., with free terminations.

SPECIMENS EXAMINED — MEXICO. SONORA: Municipality of Puerto Peñasco PAPALOTE (113°01'40.5" W 31°55'38.2" N)—in microphyllous desert scrub. Leg. A. Sánchez, I. Encinas, J. Miranda. 07.XI.2003 CESUES 5059.

OBSERVATIONS — *Valsaria* Ces. & De Not. is the subject of some controversy since some authors have placed it in *Loculoascomycetes* with bitunicate asci (Dennis 1978), while others like Barr (1990a) place it in *Pyrenomyces* with unitunicate asci. The challenging characters which we think this taxon exhibits are bitunicate asci, that Barr (1978) defined as unitunicate with “pseudo Jack-in-the-box” dehiscence and hamathecium composed of paraphyses with free terminations, which together with the presence of the peridium delimiting each fruiting layer of the stroma, makes its placement difficult.

Ju et al. (1996) published a monograph of *Valsaria* and related genera and confirmed that the asci are bitunicate, without specifying taxonomic position. Some authors include *Valsaria* in *Diaporthaceae* (Glawe 1985, Wehmeyer 1923). However, Barr (1978) did not include it in her monograph on *Diaporthales* and later included it in family *Thyridiaceae* (Barr 1990a). Huhndorf (1992) stated that the asci have a refringent apical region that is not amyloid or chitinoid, but this was not observed in the material studied, which did not react with nigrosine.

The species of *Valsaria* produce at least two anamorphic states (Glawe 1985, Huhndorf 1992) as do some species of *Thyridium* Nitschke. Ju et al. (1996) give both genera bitunicate asci and thus assume a close phylogenetic relationship between the two. Based on spore morphology and the bitunicate asci, the material studied concurs with *V. rubricosa*. Its taxonomic position is currently unresolved, so new molecular studies are required.

Valsaria rubricosa was grown on PDA medium from ascospores obtained from the fruiting body. The fungus grew as indicated by Huhndorf (1992) for *Valsonectria cinnamomi* (Ces.) Huhndorf, which was synonymised with *V. rubricosa*. Thus, after 15 days the mycelium covered the 9 cm Petri dish. In its center, the mycelium became orange and an orange pigment spread over the dish. In some Petri dishes a white pruinose band formed around this color and on the reverse side of the dish concentric circles of black dots were visible. On other dishes at 3 weeks granules 2 mm in diam. appeared, with a yellow-green or yellow-orange color. According to Huhndorf (1992) these granules are sterile stromata at first and after about two months become fertile stromata with ascospores.

Huhndorf (1992) stated that for the bicellular ascospores, in 2 to 8 hours each one of their cells germinates directly into conidia. The ascospores are surrounded by these conidia that on germination form hyphae that spread out radially from the spore, very quickly initiating a growth colony. Under the light microscope we observed the hyphae of the culture and the presence of ellipsoid to cylindrical, unicellular and hyaline conidia capable of budding from one or several loci to give rise to secondary conidia. In our cultures, we did not observe the presence of star-shaped accumulates composed of dark hyphae that form arthrospores. Huhndorf (1992) observed them in 10 to 25% of the dishes. Sterile stromata are formed by tightly packed hyphae. Also, we observed that when these stromata are formed, a reddish colored pigment spreads across the agar, the same pigment that appears with KOH 5%.

After two months, the black sterile stroma elongate, forming multiple necks spreading at the tip. After three months they are sterile at approx 2 mm diam. and 3 mm high. Under the light microscope they have a pseudoparenchymatous structure, the characteristic red pigment typical of naturally developed stroma does not appear in KOH.

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Literature cited

- Aptroot A. 1995. A monograph of *Didymosphaeria*. Studies in Mycology 37: 1-160.
 Barr ME. 1978. The *Diaporthales* in North America, with emphasis on *Gnomonia* and its segregates. Mycologia Memoir 7: 1-232.

- Barr ME. 1990a. *Melanommatales* (*Loculoascomycetes*). North American Flora. Series II Part 13, p. 1–129.
- Barr ME. 1990b. Some dictyosporous genera and species of *Pleosporales* in North America. *Memoirs of the New York Botanical Garden* 62: 1–92.
- Barr ME. 1991. Notes and additions to North American members of the *Herpotrichiellaceae*. *Mycotaxon*. 41: 419–436.
- Bellemère A, Malherbe MC, Hafellner J. 1986. Les asques bituniqués du *Lecanidion atratum* (Hedw.) Rabenh. (= *Patellaria atrata* (Hedw.) Fr.) (*Lecanidiaceae*): Étude ultrastructurale de la paroi au cours du développement et à la déhiscence. *Cryptogamie Mycologie* 7: 113–147.
- Boehm EW, Schoch CL, Spatafora JW. 2009. On the evolution of the *Hysteriaceae* and *Mytiliniidiaceae* (*Pleosporomycetidae*, *Dothideomycetes*, *Ascomycota*) using four nuclear genes. *Mycological Research* 113: 461–479.
- Breitenbach J, Kränzlin F. 1984. Fungi of Switzerland: a contribution to the knowledge of the fungal flora of Switzerland I. *Ascomycetes*. Verlag Mykologia, Luzern. 310 p.
- Chapin FS III, Matson PA, Mooney HA. 2002. Principles of terrestrial ecosystem ecology. Springer-Verlag, New York. 436 p.
- Checa J, Shoemaker RA, Umaña L. 2007. Some new hysteriaceous fungi from Costa Rica. *Mycologia* 99: 285–290.
- Chesters CGC, Bell A. 1970. Studies in the *Lophiostomataceae* Sacc. *Mycological Papers* 120: 1–55.
- Delgado-Rodríguez G, Checa J. 2002. *Hysterographium mori* (Schwein.) Rehm, nuevo registro de la familia *Hysteriaceae* (*Hysteriales*, *Ascomycotina*) para Cuba. *Boletín de la Sociedad Micológica de Madrid* 26: 57–59.
- Dennis RWG. 1978. *British Ascomycetes*. Cramer, Vaduz. 585 p.
- Glawe DA. 1985. The pleomorphic asexual state of *Valsaria insitiva* in artificial culture. *Mycologia* 77: 62–71.
- Holm L, Holm K. 1988. Studies in the *Lophiostomataceae* with emphasis on the Swedish species. *Symbolae Botanicae Uppsalienses* 28: 1–50.
- Huhndorf SM. 1992. Systematics of *Leptosphaeria* species found on the *Rosaceae*. *Illinois Natural History Survey Bulletin* 34: 479–534.
- Ju YM, Rogers JD, Huhndorf SM. 1996. *Valsaria* and notes on *Endoxylina*, *Pseudothyridaria*, *Pseudovalsaria*, and *Roussoëlla*. *Mycotaxon* 58: 419–481.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. *Ainsworth & Bisby's Dictionary of the Fungi*. 10th ed. CAB International, Wallingford. 771 p.
- Kutorga E, Hawksworth DL. 1997. A reassessment of the genera referred to the family *Patellariaceae* (*Ascomycota*). *Systema Ascomycetum* 15: 1–110.
- Linde EJ. 1992. Notes on the South African *Hysteriaceae* (*Ascomycetes: Mycotina*). *South African Journal of Botany* 58: 491–499.
- Luttrell ES. 1973. *Loculoascomycetes*. In: GC Ainsworth, F Sparrow, AS Sussman (Eds), *The Fungi: An Advanced Treatise*, vol. 4A: 135–219. Academic Press, New York & London.
- Méndez-Mayboca FR, Chacón S, Coronado ML, Esqueda M. 2007. *Ascomycetes* de Sonora, México, II: Reserva Forestal Nacional y Refugio de Fauna Silvestre Ajos-Bavispe. *Revista Mexicana de Micología* 25: 17–24.
- Méndez-Mayboca FR, Chacón S, Esqueda M, Coronado ML. 2008. *Ascomycetes* of Sonora, México. I: The Ajos-Bavispe National Forest Reserve and Wildlife Refuge. *Mycotaxon* 103: 87–95.
- Samuels GJ, Müller E. 1979. Life-history studies of Brazilian *Ascomycetes*. 7. *Rhytidhysterium rufulum* and the genus *Eutrybliella*. *Sydowia* 32: 277–292.

- Scheinflug H. 1958. Untersuchungen über die Gattung *Didymosphaeria* Fuck. und einige verwandte Gattungen. Berichte der Schweizerischen Botanischen Gesellschaft 68: 325–385.
- Vasilyeva LN. 2000. Hysteriaceous fungi in the Russian Far East III. *Glonium* and *Actidiographium*. Mykologiya i Fitopatologiya 34: 3–5.
- Wehmeyer LE. 1923. The imperfect stage of some higher *Pyrenomycetes* obtained in culture. Papers of the Michigan Academy of Science 3: 245–266.
- Zogg H. 1962. Die *Hysteriaceae* s. str. und *Lophiaceae* unter besonderer Berücksichtigung der mitteleuropäischen Formen. Beitr. Kryptogamenfl. Schweiz 11(3): 1–190.

***Entoloma trichomarginatum*, a new species of subgenus *Leptonia* (Entolomataceae) from Spain**

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Abstract — *Entoloma trichomarginatum* sp. nov. is described from Catalonia (Spain). It belongs to subgenus *Leptonia* and is characterized by the deep blue to almost blue-black tomentose pileus, bluish lamellae sides, and the sterile lamellar edge composed of almost 350 µm long cheilocystidia filled with blue intracellular pigment. A comparison with other close taxa is given, as well as photographs and drawings of the macroscopical and microscopical characters.

Key words — macrofungi, Basidiomycetes, Agaricales, biodiversity, taxonomy

Introduction

The mycobiota of Spain, and especially Catalonia, is fairly well known, and several species of *Entoloma* (Fr.) P. Kumm. have been described up to date (Maire 1933, 1937; Singer 1947, Noordeloos et al. 1992, Esteve-Raventós & De La Cruz 1998, Wölfel & Noordeloos 2001, Esteve-Raventós & Ortega 2003, Noordeloos 2004, Vila & Caballero 2007). However, in the course of a study of the macrofungi of the Natural Park of Cadí-Moixeró (Catalonia, Spain) between 2002 and 2008, we gathered a species of subgenus *Leptonia* that could not be named with the existing selected literature. The species is here proposed as a new based on morphological and ecological features.

The Natural Park of Cadí-Moixeró, mainly calcareous, is located in the north of Catalonia and belongs to the mountain range of the Pre-Pyrenees; it is dominated by a mediterranean climate in the lowlands and a warm continental climate in the highlands. Both climatological and lithological factors favor a wide range of different habitats with a high mycofloral diversity, among which some interesting findings have already been published (Llorens van Waveren & Llistosella 2004).

Materials and methods

The material studied was collected by both authors during some of their visits to the Natural Park of Cadí-Moixeró in 2006, and was photographed *in situ* using a Nikon D-100 camera.

Macroscopical description and extensive notes were made on fresh fruit bodies before they were dried. Colour notations in parenthesis have been taken from Kornerup & Wanscher (1981).

Microscopical analysis and measurements of the micromorphological structures were studied in slides mounted in Congo Red, 3% KOH and 15% NH₄OH, with a Nikon Labophot microscope, using the standard techniques. All line drawings were made with the aid of a drawing tube, and were reproduced with a digital Deltapix infinity X camera. The method used to calculate spore ranges is the one proposed by Heinemann & Rammeloo (1985) where Q_{av} corresponds to the range of the mean of Q (length/width ratio) of n spores.

Mycological terminology follows Kirk et al. (2001) and Jossierand (1952).

The material studied is deposited in BCN herbarium of the Centre de Documentació de Biodiversitat Vegetal (CDocBiv) of the Universitat de Barcelona.

Taxonomic description

Entoloma trichomarginatum Llorens van Wav. & Llistos., **sp. nov.**

FIGS 1–7

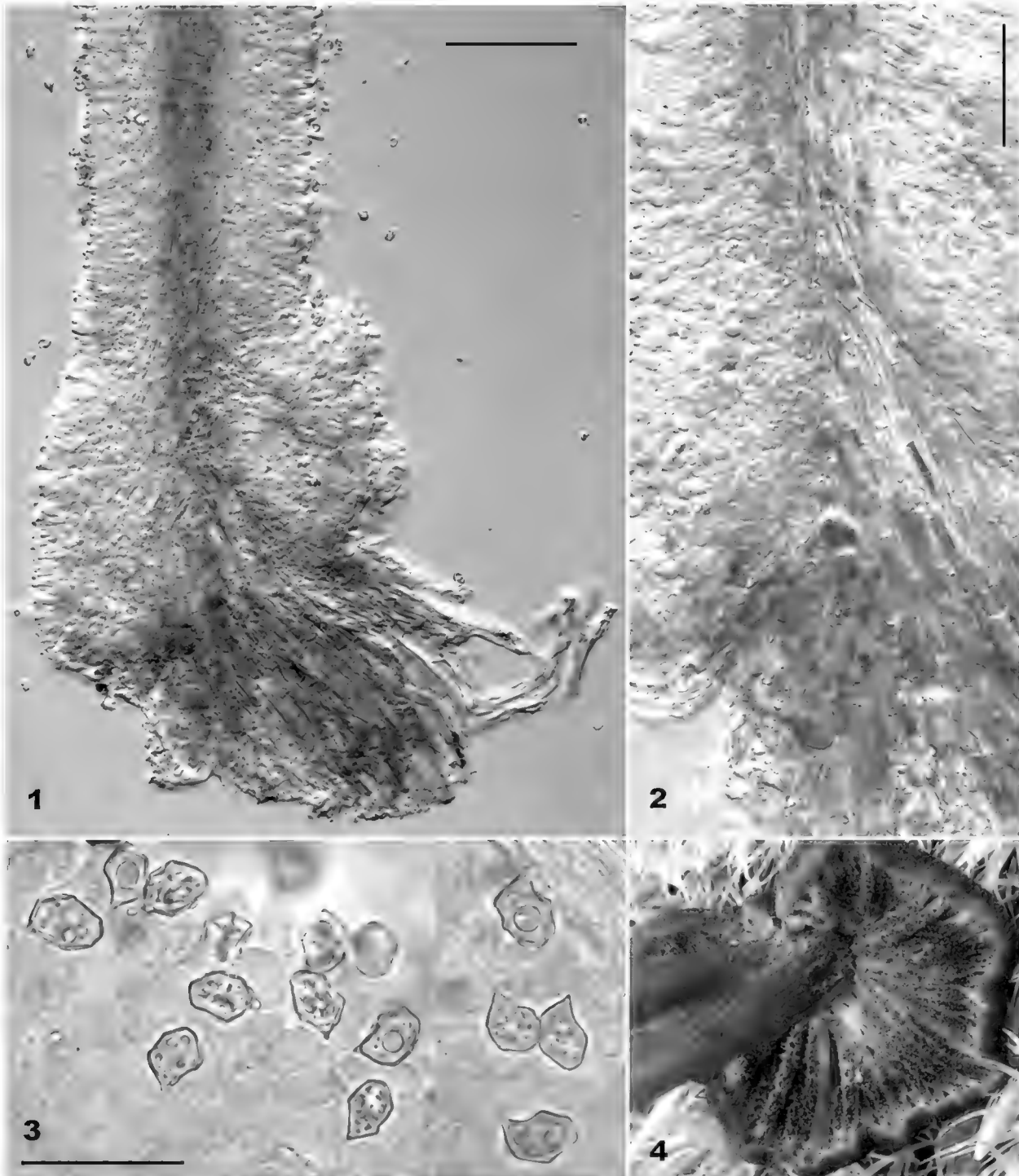
MYCOBANK 515224

Pileus 15–25 mm, a convexo ad planoconvexum parum depressus haud hygrophanus nec trans lumen striatus; coeruleo-nigrescens vel obscure coeruleus, totus tomentosus vel squamulosus. Lamellae adnatae, couruleo cinerascens; acies lamellarum flocculosa, nigro-coerulea. Stipes 40–50 mm longus 3–5 mm latus, cylindraceus, apicem versus coeruleo pruinoso, versus basim fibrilloso-squamuloso. Caro cinereo vel coeruleo pallens; odor leviter farinaceus, sapore indistincto. Sporae 9–11.5 µm longae, 6.5–8.5 µm latae, 5–7 angulatae. Basidia tetrasporigena, efibulata. Acies lamellarum sterilis; cheilocystidia usque ad 350 µm longa, 7–15 µm lata, contento caesio. Pileocutis sicut trichoderma, versus centro hymenoderma, elementis late clavatis 15–25 µm latis. Pigmentum intracellulare coeruleo. Fibulae absentes.

TYPUS: Inter muscus, in Pinus mugo subsp. uncinata silvam in solo calcareo crescens, in loco dicto Pla de Prat, prope Josa i Tuixén, in Catalaunia (Hispania), a L. Llorens van Waveren lectus, 17/X/2006, in herbario Universitatis Barcinonensis (BCN-LLVW1230, holotypus) servatus.

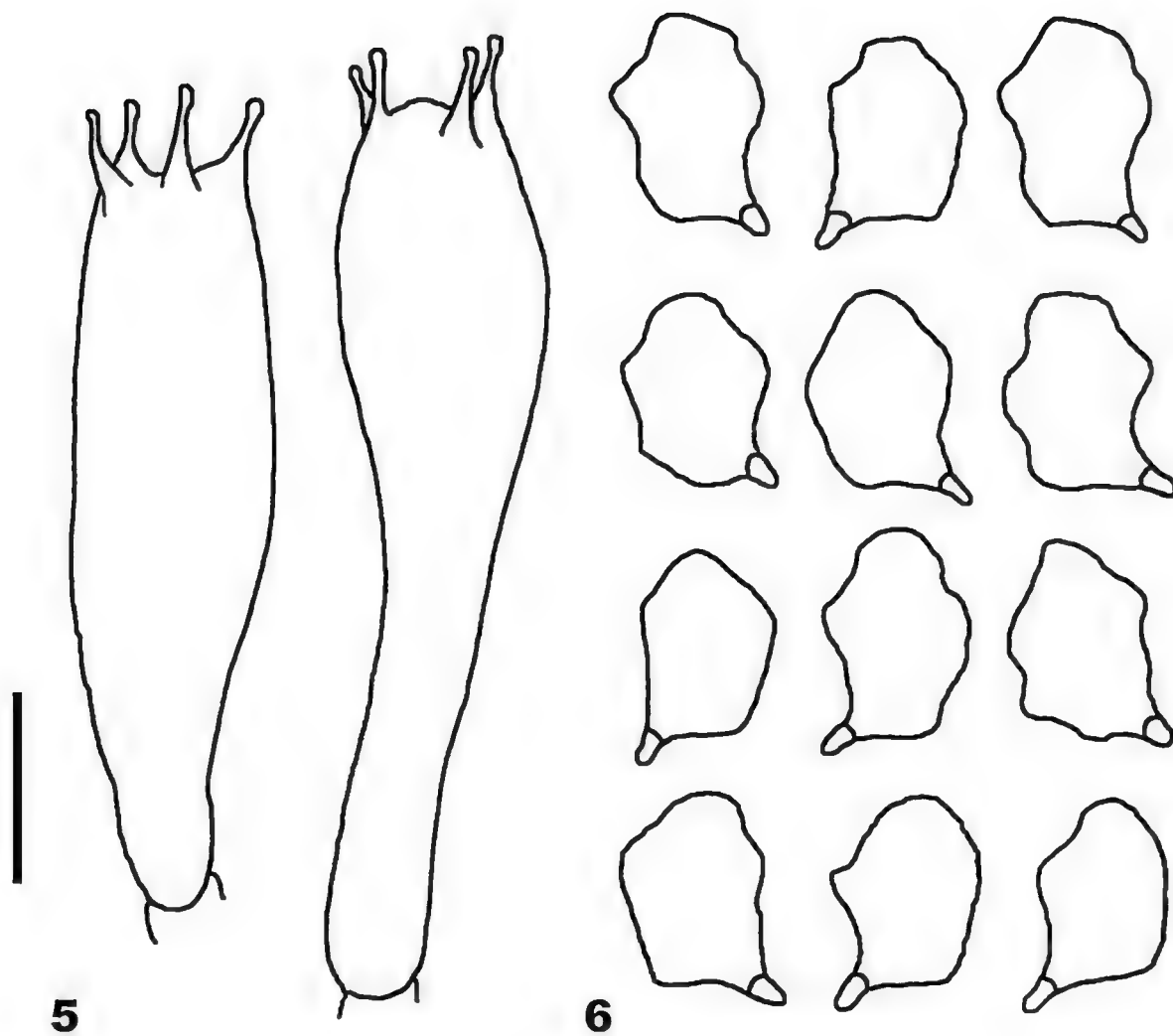
ETYMOLOGY: tricho (Greek) = hair; *margino* (Latin) = border, margin; referring to the hairy-flocculose lamella edge.

BASIDIOMATA collybioid in stature. **PILEUS** 15–25 mm diam., convex when young, expanding to plano-convex at maturity, with rounded or slightly depressed centre, rarely infundibuliform or with small papilla; surface not distinctly hygrophanous, not translucently striate; dark blackish blue to intense blue (F4 21), uniformly coloured, entirely tomentose at first, later on breaking up in radially arranged squamules, especially dense in central part; margin decurved at first, then straight, at times lobed or irregularly undulate.



FIGS 1-4. *Entoloma trichomarginatum*. 1. Cross section of the lamellar edge to show the hymenium and the blue-pigmented hymenophoral trama and cheilocystidia. Bar = 100 μ m. 2. Detail of the hymenophoral trama to show the tramal origin of the cheilocystidia. Bar = 50 μ m. 3. Mature spores. Bar = 25 μ m. 4. Macroscopical detail of the hairy-flocculose lamellar edge.

LAMELLAE, L = 15–35, l = 1–2, moderately crowded, adnate, thick; colour pale blue or greyish blue when young, then grey-blue with a pink tinge, with blue-black hairy-flocculose edge. STIPE 40–50 \times 3–5 mm, central, cylindrical or compressed, often gradually distinctly broadened towards base; dark bright blue coloured, paler than pileus, fading with age especially in the lower part, apex blue pruinose, downwards more polished but with blue scattered fibrils,



FIGS 5-6. *Entoloma trichomarginatum*. 5. Basidia 6. Spores. Bar = 10 μ m.

covered with whitish mycelium at extreme base, fistulose with age. CONTEXT blue-grey in cortex, whitish with greyish tinges in the inner parts, not changing colour when bruised. SMELL weakly farinaceous, especially when cut. TASTE mild.

BASIDIOSPORES $9-11.5 \times 6.5-8.5 \mu\text{m}$, on average $10.11 \times 7.41 \mu\text{m}$, ($Q = 1.24-1.58$, $Q_{\text{av}} = 1.38$), heterodiametrical, 5-7-angled in side view with pronounced angles. BASIDIA $35-50 \times 11-14 \mu\text{m}$, clavate, four-spored, clampless. HYMENOPHORAL TRAMA regular, of long cylindrical hyphae with abundant intracellular blue pigment. LAMELLAR EDGE sterile, composed of long sterile strands of cylindrical hyphae all along the edge of the lamellae. CHEILOCYSTIDIA numerous, up to $350 \times 7-15 \mu\text{m}$, cylindrical, apex rounded-clavate, often septate, filled with abundant blue intracellular pigment. PLEUROCYSTIDIA absent. PILEIPELLIS consisting of a trichoderm with transitions to a hymeniderm at centre, made up of inflated terminal elements, up to $15-25 \mu\text{m}$ wide, filled with intracellular blue pigment. STIPITPELLIS with pigment blue or grey-blue, exclusively intracellular. CLAMP CONNECTIONS absent from all tissues.

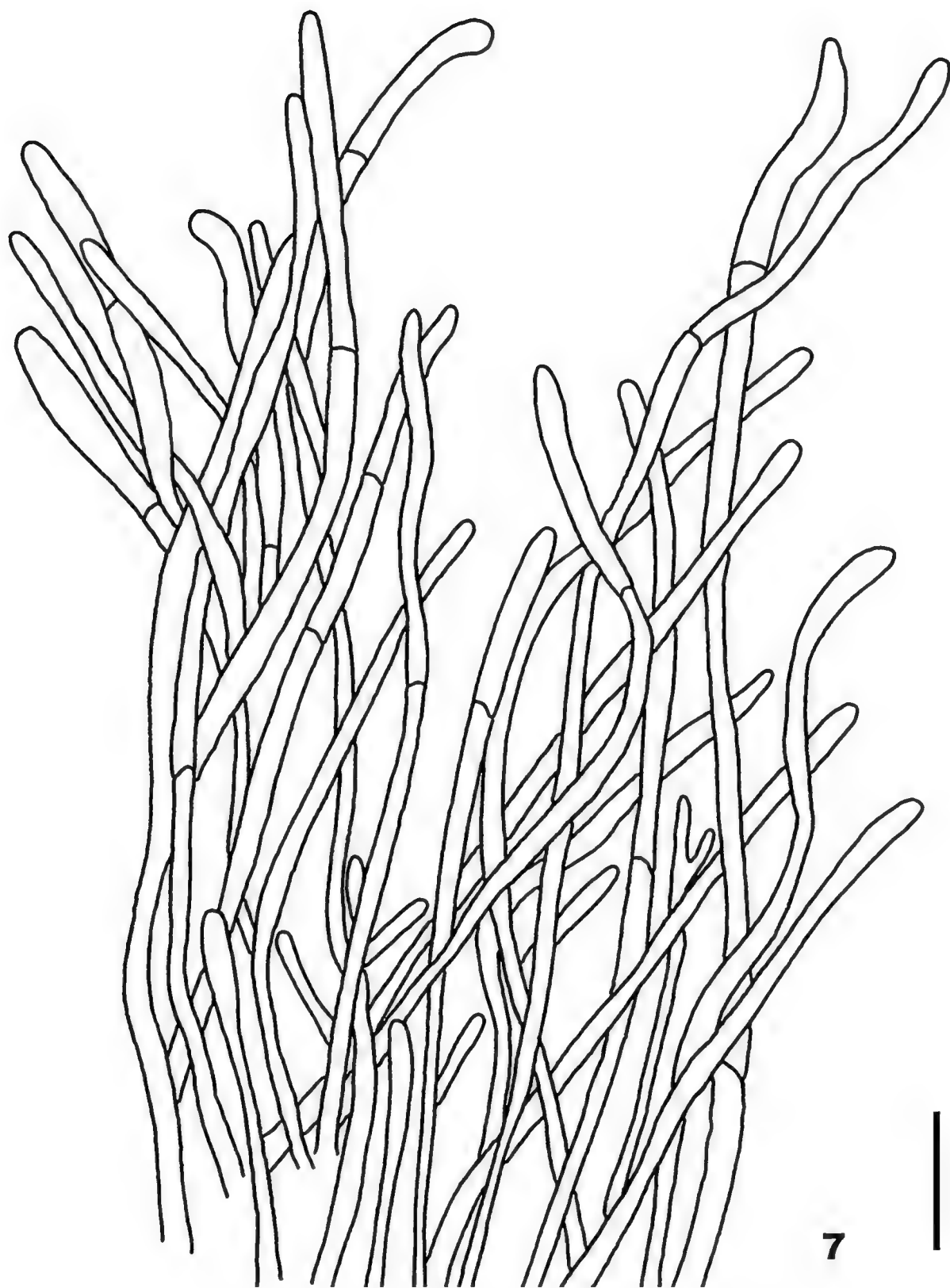


FIG 7. *Entoloma trichomarginatum*. Cheilocystidia. Bar = 40 μ m.

HABITAT: In a clearing of a *Pinus mugo* subsp. *uncinata* forest with *Juniperus communis* and *Buxus sempervirens*, in mossy soil, at 1800 m above sea level; calcareous soil.

KNOWN DISTRIBUTION: type locality.

Discussion

Entoloma trichomarginatum is referred to subgenus *Leptonia* based on its collybioid habit, typically trichodermoid pileipellis (demonstrated by the minute scales at least at centre), blue colours on pileus and stipe, and absence of clamp-connections. The combination of the strongly fimbriate structure and blue-black pigmentation of the lamellar edge, entirely composed of dense clusters of cylindrical to clavate sterile hyphae, are characteristic of stirps *Serrulatum*.

The *Serrulatum* group seems to be microscopically monotonous. In most species the heterodiametrical spores average $8\text{--}11.5 \times 6\text{--}8 \mu\text{m}$, show 5–7 angles in side view, and have a 1.2–1.7 Q ratio range. The lamellar edges is composed of inflated terminal elements of sterile hyphae (cheilocystidia) averaging $20\text{--}100 \times 3\text{--}20 \mu\text{m}$ and containing bluish, blackish or brownish intracellular pigments. Thus most species in this stirps are distinguished mainly by macroscopical characters, such as fruitbody colour and chromatic variability during development, or habitat preference.

Nevertheless, *E. trichomarginatum*, with its uniformly deep blue to almost black basidiocarp, is mainly characterised by two microscopical characters: the blue pigmented hyphae of the hymenophoral trama and the blue pigmented cheilocystidia that are more than three times longer than the average in this stirps. In this species, cheilocystidia consist of clavate to cylindrical chains of sterile hyphae that originate from within the hymenophoral trama and extend beyond the lamellar edge, giving it an extraordinarily flocculose appearance. According to the literature (Horak 1978, Noordeloos 1992, Vesterholt 2002, Noordeloos 2004) no other described *Entoloma* species produces cheilocystidia of this size. Furthermore, *E. trichomarginatum* exudes a weakly farinaceous odor, contrasting with the lack of odor noted for all species in stirps *Serrulatum*. It should be noted, however, that several species in subgenus *Leptonia* (e.g., *E. dichroum* (Pers.) P. Kumm., *E. placidum* (Fr.) Noordel., *E. violaceozonatum* Noordel. & Liiv, *E. juniperinum* Barkman & Noordel.) do have this characteristic farinaceous smell.

Similar blue-coloured species with pigmented cheilocystidia include *E. chalybeum* (Pers.) Noordel., *E. serrulatum* (Fr.) Hesler, *E. caesiocinctum* (Kühner) Noordel., and *E. gomerense* Wölfel & Noordel. *Entoloma chalybeum* resembles *E. trichomarginatum* in basidiocarp colour, habit, and pale blue to greyish lamellae (most easily observed in young specimens) but differs in having much shorter cheilocystidia with an irregular brown intracellular pigments. The cosmopolitan *E. serrulatum*, with a characteristic bright blue pileus and stipe and an irregular lamellar edge with blue-pigmented cheilocystidia, differs lacking the blue tinges on the lamellar faces and serrulate, less flocculose lamellar edge.

However, *E. serrulatum* var. *nigrovenosum* Courtec., which shares almost the same macroscopical characters with *E. trichomarginatum*, can be recognized by its more rounded, rugulose pileus that is much darker, almost black, and with a slight blue tinge that does not fade with age (Courtecuisse 1993). *Entoloma trichomarginatum* has been found in a habitat similar to that of *E. serrulatum*, which is common in grasslands and grassy vegetations in temperate, boreal and subalpine regions (Noordeloos 1984, Noordeloos & Gulden 1989), but it also occurs in alpine and arctic regions. *Entoloma caesiocinctum* can be distinguished from *E. serrulatum* by the brown pileus that is tinged slightly blue at the margin and less tomentose-squamulose. The completely translucent, striate pileus and $\leq 50 \mu\text{m}$ long cheilocystidia depicted in the description and illustration of *E. gomerense* by Wölfel & Noordeloos (2001) are additional distinguishing characters.

Most other members of the stirps differ mainly by the colour of pileus and stipe, by which it is possible to distinguish the following species: *E. querquedula* (Romagn.) Noordel. with olivaceous tinges, *E. carneogriseum* (Berk. & Broome) Noordel. with pale pinkish brown or yellow-brown colours, *E. callirhodon* Hauskn. & Noordel. with a striking pink reddish colour, *E. violaceoserrulatum* Noordel. with violaceous tinges, and *E. xanthoserrulatum* Noordel. & Vauras with predominantly yellow colours. Moreover, *E. linkii* (Fr.) Noordel., which has blue colours only at the lamellar edge, is always found on wood remains of *Fagus sylvatica*. Lastly, *E. brunneoserrulatum* Eyssart. & Noordel., has a brown pileus, brown lamellar edge, and larger, 11–13 μm long basidiospores.

Future DNA sequence-based studies will help circumscribe the different species and establish a more sound taxonomical vision of this difficult *Serrulatum* group.

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Literature cited

Courtecuisse R. 1993. Macromycetes intéressants, rares ou nouveaux (VI) *Entolomataceae*. Documents Mycologiques 23: 1–38.

- Esteve-Raventós F, De La Cruz M. 1998. *Entoloma exiguum*, a new species of subgenus *Claudopus* (*Entolomataceae*, *Agaricales*) from Spain. *Persoonia* 17: 141–144.
- Esteve-Raventós F, Ortega A. 2003. *Entoloma alliiodorum*, a new species of subgenus *Claudopus* with a garlic odour. *Mycotaxon* 86: 227–232.
- Heinemann P, Rammeloo J. 1985. De la mesure des espores et son expression. *Agarica* 6: 366–380.
- Horak E. 1978. *Entoloma* in South America. I. *Sydowia* 30: 40–111.
- Josserand M. 1952. La description des Champignons Supérieurs. Lechevalier. Paris.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Dictionary of the Fungi. 9th Edition. CAB International. Wallingford, UK.
- Kornerup A, Wanscher JH. 1981. Taschenlexikon Der Farben – 1440 Farbnuancen und 600 Farbnamen. Muster-Schmidt Verlag. Zürich. Göttingen.
- Llorens van Waveren L, Llistosella J. 2004. Contribució a la flora dels Fongs del Parc Natural del Cadí-Moixeró (Catalunya). I. El gènere *Entoloma* (Fr.) P. Kumm. *Revista Catalana de Micologia* 26: 165–176.
- Maire R. 1933. Fungi Catalaunici. Contributions à l'étude de la Flore Mycologique de la Catalogne. *Treballs del Museu de Ciències Naturals de Barcelona* 15: 1–120.
- Maire R. 1937. Fungi Catalaunici. Contributions à l'étude de la Flore Mycologique de la Catalogne. *Publicacions de l'Institut Botànic* 3(4): 1–128.
- Noordeloos ME. 1984. *Entolomataceae* (*Agaricales*, *Basidiomycetes*) in Greenland. I. The genus *Entoloma*. *Persoonia* 12: 263–305.
- Noordeloos ME. 1992. *Entoloma* s.l. *Fungi Europaei*. vol. 5. Giovanna Biella. Saronno, Italia.
- Noordeloos ME. 2004. *Entoloma* s.l. (Supplemento). *Fungi Europaei*. vol. 5a. Massimo Candusso, Alassio, Italia.
- Noordeloos ME, Gulden G. 1989. *Entoloma* (*Basidiomycetes*, *Agaricales*) of alpine habitats on the Hardangervidda near Finse, Norway, with a key including species from Northern Europe and Greenland. *Canadian Journal of Botany* 67: 1727–1738.
- Noordeloos ME, Tabarés M, Rocabruna A. 1992. A new species of *Entoloma* subgenus *Pouzarella* from Spain. *Persoonia* 15: 123–125.
- Singer R. 1947. Champignons de la Catalogne. Espèces observées en 1934. *Collectanea Botanica* 1: 199–246.
- Vesterholt J. 2002. Contribution to the knowledge of species of *Entoloma* subgenus *Leptonia*. *Fungi non delineati* 21: 1–63.
- Vila J, Caballero F. 2007. *Entoloma* nuevos o interesantes de la Península Ibérica. *Fungi non delineati* 38: 63.
- Wölfel G, Noordeloos ME. 2001. Neue older bemerkenswerte *Entoloma*- Arten der Kanarischen Inseln. *Österr. Zeitschr. f. Pilzk.* 10: 185–200.

***Hirsutella liboensis*, a new entomopathogenic species affecting *Cossidae* (Lepidoptera) in China**

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Abstract — *Hirsutella liboensis* was isolated from the larva of *Cossidae* (Lepidoptera) in Libo Natural Reserves, Guizhou Province. The fungus produces fasciculate synnemata and mono- and polyphialidic conidiogenous cells with necks twisted in two or three helical turns. Conidia are one-celled or (rarely) one-septate, fusiform or like orange segments that are enveloped in a mucous sheath. Morphological characters and phylogenetic analyses of ITS1-5.8S-ITS2 sequences support this fungus as a new species.

Key words — *Cordyceps*, taxonomy, entomopathogen

Introduction

The genus *Hirsutella* Pat. (Patouillard 1892) is important because of its capacity for serving as a natural control factor to insects, mites, and nematodes. Recent research has shown that some *Hirsutella* species produce various valuable bioactive compounds that could be used in anti-tumor (He et al. 2008), anti-tuberculosis (Isaka et al. 2008), and anti-malaria (Thongtan et al. 2006) capacities. Some authors consider the helical neck of conidiogenous cell is a crucial character in differentiating individual *Hirsutella* species (Mains 1951; Liang 1990a,b; Hodge 1998). Six species with conidiogenous cells possessing helical or wavy necks are currently known: *Hirsutella nodulosa* Petch (Petch 1926); *Hirsutella parasitica* (Henn.) Samson & H.C. Evans and *Hirsutella dendritica* Samson & H.C. Evans (Samson & Evans 1991); *Hirsutella brownorum* Minter & B.L. Brady (Minter & Brady 1980); *Hirsutella leizhouensis* H.M. Fang & S.M. Tan (Fang & Tan 1992); and *Hirsutella vermicola* M.C. Xiang & Xing Z. Liu (Xiang et al. 2006). In this paper we report a new species with conidiogenous cells that also have a helical neck from larvae of *Cossidae* (Lepidoptera).

* Corresponding author.

TABLE 1. List of fungi and GenBank accession numbers used in this paper.

FUNGUS	GENBANK #	FUNGUS	GENBANK #
<i>Chaunopycnis pustulata</i>	AF389189	<i>H. vermicola</i>	DQ345592
<i>Elaphocordyceps capitata</i>	AB027364	<i>Ophiocordyceps agriotis</i>	AY245626
<i>E. inegoensis</i>	AB027368	<i>O. cochliidiicola</i>	AB027377
<i>E. ophioglossoides</i>	AB027367	<i>O. emeiensis</i>	AJ309347
<i>E. ophioglossoides</i>	AJ309360	<i>O. multiaxialis</i>	AJ309359
<i>E. paradoxa</i>	AB027369	<i>O. nepalensis</i>	AJ309358
<i>Hirsutella gregis</i>	EF194155	<i>O. robertsii</i>	AJ309335
<i>H. liboensis</i>	FJ957852	<i>O. rubiginosoperitheciata</i>	AB294423
<i>H. nodulosa</i>	EF194146	<i>O. sinensis</i>	AB067715
<i>H. rhossiliensis</i>	AB109740	<i>O. sinensis</i>	AJ309357
<i>H. rhossiliensis</i>	DQ345587	<i>Tolypocladium cylindrosporum</i>	AB044645
<i>H. sinensis</i>	AJ309353	<i>T. inflatum</i>	AB208110
<i>H. sinensis</i>	AJ309355		

Materials and methods

Isolation and culture of collections

Infected hosts were surface-sterilized for 5 s with 75% ethanol, broken open to expose the body cavity, and then small tissue blocks and fungal hyphae were placed aseptically on potato dextrose agar (PDA) plates. The plates were incubated at 22°C and dark. After 14 d, the colonies can be observed. Select these pure colonies for identification and deposition of strains. The strain of GZUIFR-Libo1 was cultured on Czapek and Sabouraud media for identification. The cultures of this strain were maintained under 12 h:12 h /light:dark at 22°C or at 20–28 °C.

DNA extraction, amplification, and sequencing

Axenic mycelia (about 1 g) of *H. liboensis* strains were collected from PDA plate and used for DNA extraction according to Tigano-Milani et al. (1995). The extracted DNA was stored at -20 °C. The rDNA gene ITS-5.8S region was amplified using the primers ITS5 (5'-GGT GAGAGATTTCTGTGC-3') and ITS4 (5'-TCCTCCGCTTATTGATATGC-3') (White et al. 1990). PCR amplification was performed as follows: at 94°C for 5 min and 35 cycles with at 94°C for 40 s, at 49°C for 40 s, at 72°C for 60 s; followed by a final elongation step at 72°C for 10 min. PCR products were purified and sequenced by Beijing Sunbiotech Co. Ltd. The sequence of ITS1-5.8S-ITS2 rDNA region of strain GZUIFR-Libo1 was submitted to GenBank.

Phylogenetic analysis

The ITS1-5.8S-ITS2 nucleotide sequence of strain GZUIFR-Libo1 was aligned using the Clustal X1.83 with related fungi sequences (Table. 1) from GenBank. The phylogenetic analysis was performed by neighbor-joining method (NJ) of MEGA version 4.0 (Kumar et al. 2004). Confidence values for individual branches were determined by bootstrap analysis (1000 replications).

TABLE 2. Morphological comparison between *Hirsutella liboensis* and similar *Hirsutella* species.

SPECIES	PHIALIDES	CONIDIA	HOST	SYNNEMATA
<i>H. brownorum</i>	not poly-phialidic	lemon-shaped 5–6 × 4–5 µm	Mite	none
<i>H. dendritica</i>	wavy neck	fusiform, non-mucoid, 6–8 × 2–3 µm	Pupae	single
<i>H. leizhouensis</i>	warted, in opposite pairs	oviform, non-mucoid, 3.5–4.5 × 2–3 µm	<i>Phragmatoecia castaneae</i>	clustered
<i>H. liboensis</i>	single, smooth, polyphialidic,	fusiform, in mucoid sheath, 6–10 × 1.5–4 µm	<i>Cossidae</i>	clustered larva
<i>H. nodulosa</i>	rough-surfaced	non-mucoid, 3–5 × 3 µm	Mite	none
<i>H. parasitica</i>	wavy neck	cylindric, non-mucoid 12–25 × 2.5–4 µm	Unknown	clustered
<i>H. vermicola</i>	singly or in opposite pairs	ellipsoid or like orange segments, 7–8 × 1.5–3 µm	Nematode	none

Results and discussion

Taxonomy

Hirsutella liboensis X. Zou, A.Y. Liu & Z.Q. Liang, sp. nov.

FIG. 1

MYCOBANK MB 513283; GENBANK FJ957852

Coloniae in Czapek agaro lente crescentes, albae, 2–3 mm diam post 21 dies. Mycelium hyalinum, septatum, laeve. Conidiophoris ad cellulas conidiogenas singulatim producentis ex hyphis vegetativis. Cellulis conidiogenis mono-phialidicis, rarius polyphialidicis, 28–30 µm longis, basi parte inflatis, 18–20 × 3–4.5 µm, apice 1–2 µm latis, 2–3 helicinis. Conidiis aseptatis vel septatis, levibus, singulatim vel 2 aggregate ad colli apicem facientibus, plus minusve ellipsoideis, 6–8 µm longis, 3–5 µm latis, in muco involutis.

HOLOTYPE: GZUXIFR-Libo1, isolatus ex insectus, X. Zou, Libo, Provincia Guizhou, VI, 2007; in Guizhou Univ., conservatus. The holotype and isolated strains are deposited in the Institute of Fungus Resources, Guizhou University.

ETYMOLOGY: *liboensis*, referring to the collection location.

Colonies on Czapek agar, 25°C, growing very slowly, up to a diam of 2–3 mm after 3 weeks. Mycelium hyaline, septate, smooth. Conidiogenous cells single, almost at right angles from vegetative hyphae, monophialidic or polyphialidic, hyaline, smooth, 28–30 µm long, significantly swollen in basal portion, 3–4.5 µm width, tapering to 1–2 µm wide and 10–13 µm overall length, twisting in 2–3 helices at the apex. Conidia hyaline, aseptate or with a septum, smooth, fusiform or like orange segments, arising singly (or both-cell) from the apex of the neck, 6–8 µm long, 3–5 µm wide, enveloped in a hyaline mucous sheath. Colonies on PDA, 22–24°C, in light, producing synnemata after 60 d; synnemata up to 40–50 mm length after 90 d. No teleomorph was observed.

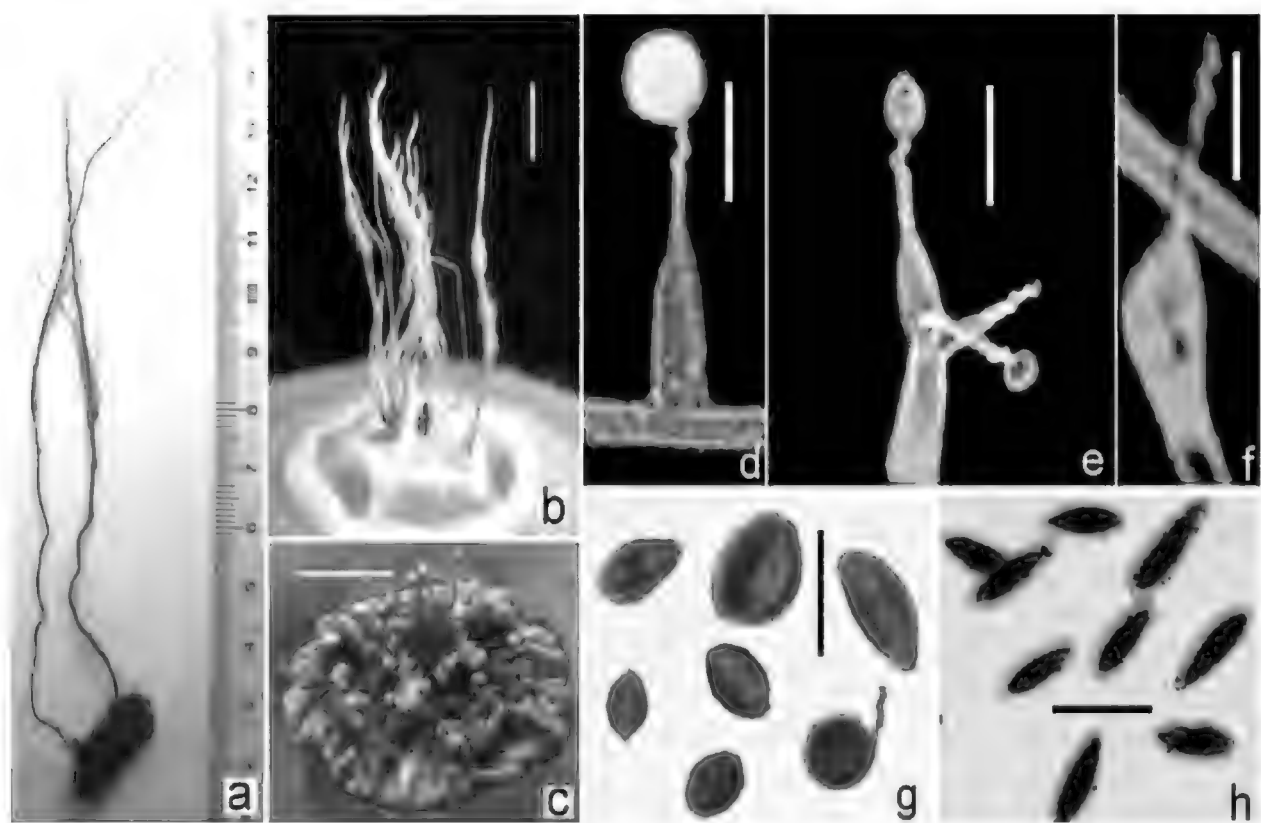


FIG. 1 Synnemata and conidiogenous structures of *Hirsutella liboensis*. a. Synnemata on insect; b. Synnemata on PDA; c. Culture on Sabouraud medium; d. Single erect phialides; e. Proliferating phialides; f. Phialides with 2–3 helices; g. Conidia with mucus sheath; h. Conidia from specimen synnemata. Bar = 10 mm (b–c) or 10 μm (d–h).

HOST: Larva of a species of *Cossidae* (*Lepidoptera*) in a tree hole.

ADDITIONAL SPECIMEN EXAMINED (PARATYPE): GZUIFR-Libo1, Libo, Provincia Guizhou, VII, 2007; Guizhou Univ.

The most typical character of *H. liboensis* is the helical twist of the necks of the phialides, a feature shared in common with six other *Hirsutella* species. The differences separating the seven species are compared in TABLE 2 below.

Molecular analyses

A BLAST search of GenBank was performed by using the *H. liboensis* ITS-5.8S sequence. Close matches showing maximal sequence identities of 94–97% included *Ophiocordyceps cochliidiicola* (Kobayasi & Shimizu) G.H. Sung et al., *H. nodulosa*, and *H. vermicola*. The ITS sequences of these species, related species of *Hirsutella*, and other entomogenous fungi were retrieved from GenBank for phylogenetic analysis, which clearly supported three clades (FIG. 2). Clade-B included an independent sub-clade comprising *O. cochliidiicola*, *H. nodulosa*, *H. vermicola*, and *H. liboensis*.

Many *Hirsutella* species are the anamorphs of *Ophiocordyceps* (Liang 1990a). Recent data showed also that *Hirsutella* is an anamorphic genus of *Ophiocordyceps* Petch (Sung et al. 2007). Liu et al. (2005) described a fungus

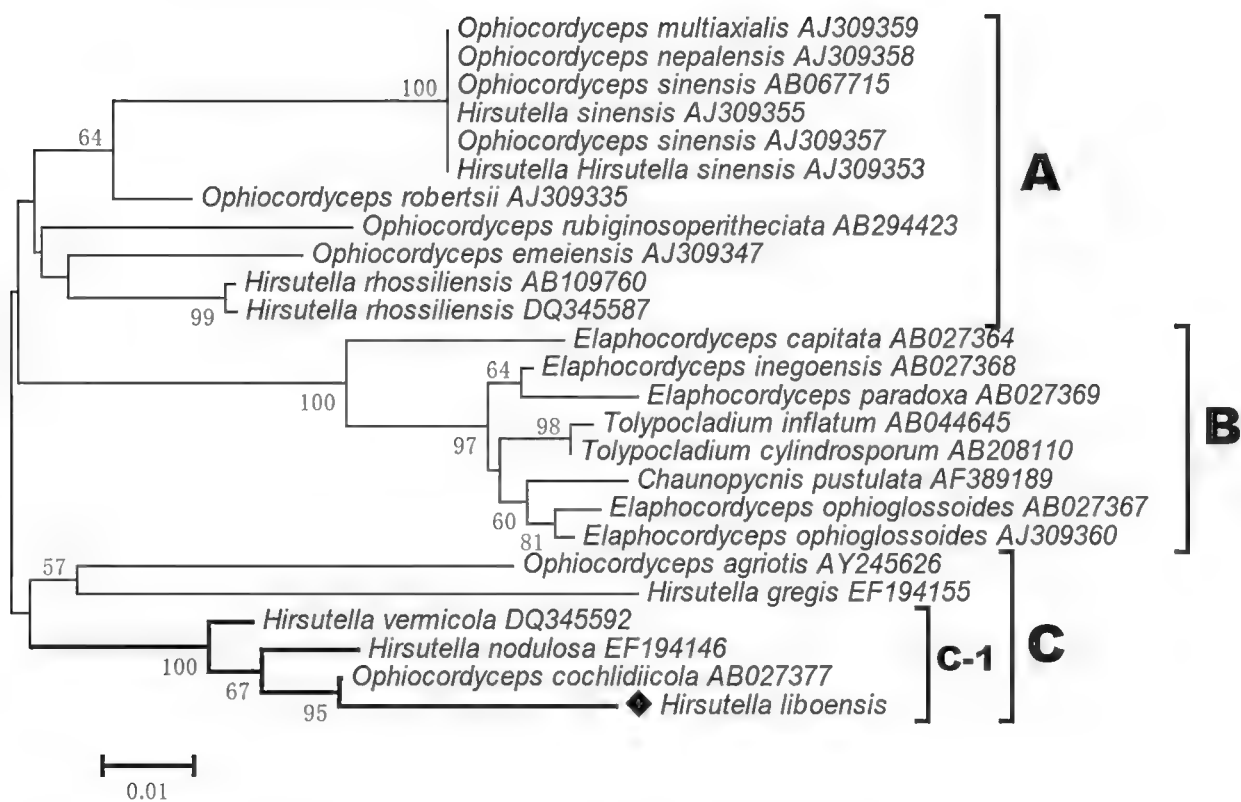


FIG. 2 Phylogenetic tree based on rDNA ITS1–5.8S–ITS2 sequences of *H. liboensis* and related species.

with pleoanamorphic states characteristic of both *Aschersonia* and *Hirsutella*. *Aschersonia* species linked exclusively to teleomorphs in the genus *Hypocrella*. It can be seen that *Hirsutella* has a mixed and paraphyletic phylogenetic background.

Hirsutella liboensis clustered in subclade C–1, which included *H. nodulosa* and *H. vermicola* with helical or curved necks atop the phialides. *Hirsutella vermicola* infects nematodes and has oppositely paired phialides while *H. nodulosa* has phialides with a warted surface and a greater length/width ratio. Genetic distances show *Hirsutella liboensis* and *Ophiocordyceps cochliidiicola* with the closest relationship. Kobayasi & Shimizu (1980) reported that *O. cochliidiicola* could infect larva of *Cochliidiidae* (*Lepidoptera*) and its stroma was single, thin, fibers, dust-color, 70–100 × 1 mm. Until now, the *O. cochliidiicola* anamorph has been unknown. As the *H. liboensis* teleomorph is also unknown, the relationship between the two forms will be further studied and analyzed. Two other related species, *O. agriotis* Sung GH et al. [as ‘*agriotidis*’, nom. inval.] and *H. gregis* Minter et al. were also grouped in clade C (supported by 57%) but group together outside the *H. liboensis* sub-clade, C–1.

In a word, both morphological characters and phylogenetic analysis support *H. liboensis* as a new species of *Hirsutella*.

Acknowledgments

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References

- Fang HM, Tan SM. 1992. A new species of *Hirsutella leizhouensis* Fang & Tan. *Acta Mycologica sinica* 11: 28–31.
- He YQ, Hu FL, Li CR, Zuo DP, Liu YJ, Fan MZ. 2008. Antitumor activities of extracts from mycelium of 40 entomogenous fungi. *Journal of Anhui Agricultural University* 35: 84–88.
- Hodge KT. 1998. Revisionary studies in *Hirsutella* (*Hyphomycetes*). [PhD Dissertation]. Ithaca, New York: Cornell University.
- Kobayasi Y, Shimizu D. 1980. *Cordyceps* species from Japan 3. *Bull. Nat. Sci. Mus., Ser. Bot.* 6: 125–145.
- Kumar S, Tamura K, Nei M. 2004. MEGA3: Integrated software for molecular evolutionary genetics analysis and sequence alignment. *Briefings in Bioinformatics* 5: 150–163.
- Liang ZQ. 1990a. Studies on classification of the genus *Hirsutella* Pat. I. Advances and the characteristics of taxonomy. *Journal of Guizhou Agriculture College* 9: 58–68.
- Liang ZQ. 1990b. Classification of the genus *Hirsutella* Pat. II. Key of species to the genus *Hirsutella* Pat. *Southwest China Journal of Agricultural Sciences* 3: 32–39.
- Liu M, Rombach MC, Humber RA, Hodge KT. 2005. What in a name? *Aschersonia insperata*: a new pleoanamorphic fungus with characteristics of *Aschersonia* and *Hirsutella*. *Mycologia* 97: 246–253.
- Minter DW, Brady BL. 1980. Monomatous species of *Hirsutella*. *Trans. Br. Mycol. Soc.* 74: 273–274.
- Isaka M, Hywel-Jones NL, Somrithipol S, Kirtikara K, Palittapongarnpim P, Thebtaranonth Y. 2006. Antituberculosis compounds, Hirsutellones A, B, and C. US Patent 7,414,069 (19 Aug 2008).
- Mains EB. 1951. Entomogenous species of *Hirsutella*, *Tilachilidium* and *Synnematium*. *Mycologia* 43: 691–718.
- Patouillard N. 1892. Une Clavariée entomogène. *Rev. Mycol. (Toulouse)* 14: 67–70.
- Petch T. 1926. Entomogenous fungi. Additions and corrections, II. *Trans. Br. Mycol. Soc.* 11: 258–266.
- Samson RA, Evans HC. 1991. Taxonomic status of *Didymobotryopsis* (*Hyphomycetes*) and description of a new *Hirsutella* species. *Mycol. Res.* 95: 887–888.
- Sung G-H, Hywel-Jones NL, Sung J-M, Luangsa-ard JJ, Shrestha B, Spatafora JW. 2007. Phylogenetic classification of *Cordyceps* and the clavicipitaceous fungi. *Studies in Mycology* 57: 5–59.
- Thongtan J, Saenboonrueng J, Rachtawee P, Isaka M. 2006. Antimalarial tetrapeptide from the entomopathogenic fungus *Hirsutella* sp. BCC 1528J. *Nat. Prod.* 69: 713–714.
- Tigano-Milani MS, Samson RA, Martins I, Sobral BWS. 1995. DNA markers for differentiating isolates of *Paecilomyces lilacinus*. *Microbiology* 141: 239–245.
- Xiang MC, Yang EC, Xiao QM, Liu XZ, Chen SY. 2006. *Hirsutella vermicola* sp. nov., a new species parasitizing bacteria-feeding nematodes. *Fungal Diversity* 22: 255–266.

***Punctelia osorioi*, a new species of *Parmeliaceae* from South Brazil**

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Abstract—During a survey in Southern Brazil, *Punctelia osorioi* was recognized as a new species similar to *Punctelia bolliana* differentiated by a pale lower surface, unciform conidia, and no medullary reactions.

Key words—*Punctelia purpurascens*, *Punctelia tomentosula*, taxonomy, lichenized fungi

Introduction

The genus *Punctelia* is characterized by punctiform pseudocyphellae on the upper surface, the presence of atranorin in the upper cortex, associated either with medullary depsides (lecanoric and/or gyrophoric acids) or fatty acids, and unciform or filiform conidia (Krog 1982). *Punctelia* is considered to occur worldwide (Kirk et al. 2008), and contains about forty-two species. Several new species have been discovered in this decade, especially in the Americas (Canêz & Marcelli 2007, Marcelli et al. 2009).

With 28 species recorded, South America exhibits the highest diversity for *Punctelia* (Krog 1982, Canêz & Marcelli 2006a). Brazil alone has 24 species, representing 49% of the world's species. Six of these have a pale lower surface: *P. canaliculata* (Lynge) Krog (Lynge 1914), *P. crispa* Marcelli et al., *P. digitata* Jungbluth et al., *P. roseola* Jungbluth et al. (Marcelli et al. 2009), *P. punctilla* (Hale) Krog (Jungbluth 2006), and *P. purpurascens* Marcelli & Canêz (Canêz & Marcelli 2007). Of those, only *P. purpurascens* produces only fatty acids in the medulla (C–).

During a survey in Vacaria Municipality, Rio Grande do Sul State (Canêz 2005, 2009), a new species with pale lower surface and producing fatty acids in the medulla was recognized and is presented below.

Material and methods

Morphological characters were examined under a stereomicroscope and Canêz & Marcelli (2006b) were followed for the standard description. Anatomical sections of apothecia and pycnidia were made with razor blades and studied under a compound microscope. The chemical constituents were analyzed by color reaction (spot tests), including potassium hydroxide (K), sodium hypochlorite (C) and para-phenylenediamine (P), by UV light, and by thin-layer chromatography (TLC) using solvent C, following Culberson & Kristinsson (1970), Huneck & Yoshimura (1996), and Bungartz (2001).

Type specimens of the similar species were studied for comparisons.

New species

Punctelia osorioi Canêz & Marcelli, sp. nov.

FIG. 1

MYCOBANK MB 515231

DIAGNOSIS: *Similis* *Puncteliae bollianae medulla C-* et *conidiis unciformibus sed pseudocyphellis abundantibus et rhizinis multis densisque differt.*

HOLOTYPE—Brazil, Rio Grande do Sul State, municipality of Vacaria, locality of Fazenda da Estrela, open field, 28°02'44.6"S, 51°02'01.7"W, 860 m alt. on shrub branch in the right margin of the Frade River, with mosses and pteridophyte, leg. L.S. Canêz & A.A. Spielmann 665, 11-I-2004 (SP).

THALLUS gray to greenish gray, lobate, to 13 cm in diameter; lobes irregularly branched, 0.9–4.0(–4.5) mm wide, adnate to loosely adnate, contiguous to slightly overlapping laterally, apices round, margins entire to crenate, upper surface continuous, rugose to slightly scrobiculate; LACINULAE sometimes present, few, simple, marginal on the central thallus area, pseudocyphellae mainly on the margins, pycnidiate on the subapices, 0.6–1.0 × 0.4–0.7 mm size. MACULAE absent; PSEUDOCYPHELLAE white, subtle to inconspicuous, more frequently plane, punctiform to ellipsoid, 0.05–0.15(–0.30) mm in diameter, sometimes originating from cracks in the center, abundant on lamina and amphithecium; SORALIA and ISIDIA absent. MEDULLA white, pigment absent. LOWER SURFACE pale brown or white in some areas, slightly shiny, smooth to rugose; MARGINAL ZONE concolorous with the central surface, shiny, smooth, rarely rugose or papillate, rhizinate or sometimes naked, <0.10–0.60(–1.00) mm; RHIZINAE concolorous with the lower surface or white, rarely darkened towards the tips, simple to irregularly branched, shorter ones (0.15–)0.25–0.95 × 0.05 mm and longer ones 1.00–1.65 × 0.06–0.09 mm, dense like a tomentum, evenly distributed. APOTHECIA concave to cupuliform, 2.0–8.0 mm in diameter, adnate, short pedicellate, laminal to submarginal, margin smooth, amphithecium pseudocyphellate and slightly wrinkled; disc ochre, imperforate; ASCOSPORES ellipsoid, (10–)12–15(–17.5) × 7–10(–12) µm, epispore 1.2(–2.0) µm. PYCNIDIA submarginal to marginal, ostiole black; CONIDIA unciform, (3.8–)5.0–6.0 µm.

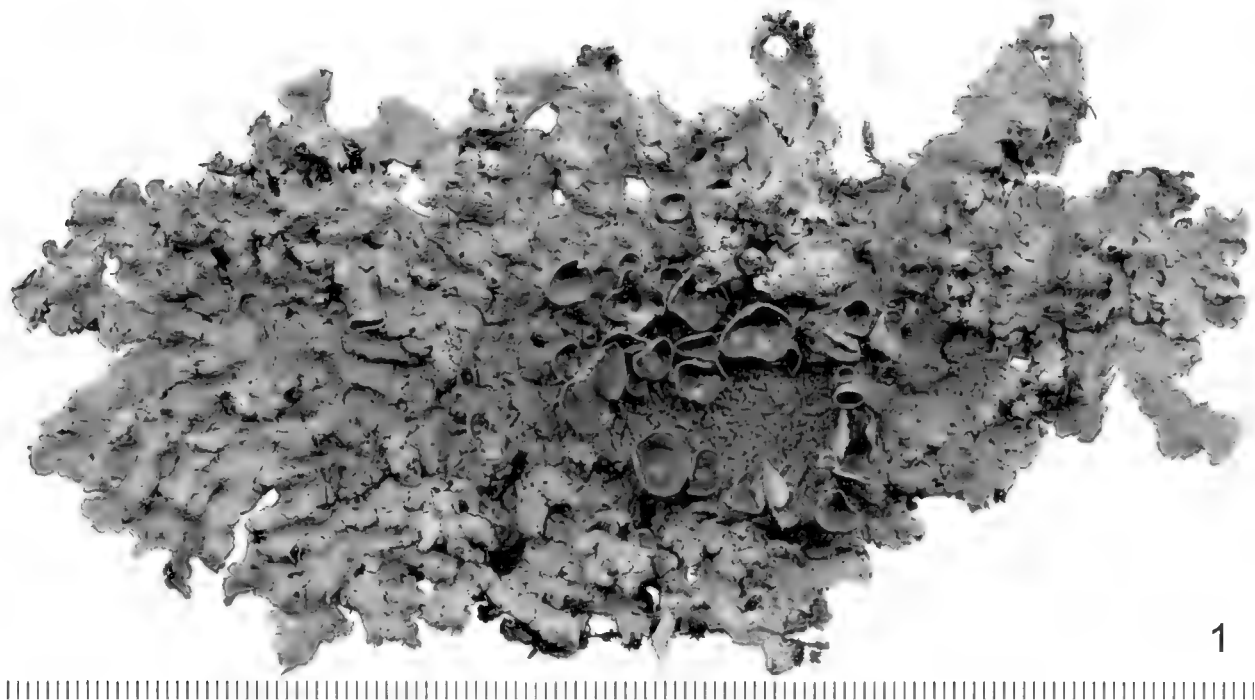


FIGURE 1. Holotype of *Punctelia osorioi* in SP. Scale in millimetres.

SPOT TESTS: cortex K+ yellow, UV–; medulla K–, C–, KC–, P–, UV–.

TLC: traces of atranorin (cortex) and caperatic acid-like fatty acid (medulla).

PARATYPES—Brazil, Rio Grande do Sul State, municipality of Vacaria, locality of Fazenda da Estrela, field with spread trees, 28°01'58"S, 50°58'17.5"W, 900 m alt., on branch of roadside tree, leg. L.S. Canêz & A.A. Spielmann 424 (SP), 19-VII-2003; idem, on cortex of roadside tree, leg. L.S. Canêz & A.A. Spielmann 393 (SP, B), 19-VII-2003; idem, open forest, 28°04'16.6"S, 50°55'39.7"W, 930 m alt., corticolous on forest border, leg. L.S. Canêz & A.A. Spielmann 737 (SP), 12-I-2004.

COMMENTS— *Punctelia osorioi* is characterized by the abundant and subtle or inconspicuous pseudocyphellae, the pale brown lower surface, unciform conidia, dense rhizinae (like a tomentum), and a medulla producing caperatic acid (C–).

Lacinules were seen only on the holotype. They occur at the center of the thallus near apothecia and are simple, originating from the lobe margins.

In this species it is possible to find rhizinae projecting beyond the margins of some lobes, resembling short cilia. They are sparse, black, more frequently in the lobe axils, simple, and up to 0.3 mm long.

Punctelia bolliana (Müll. Arg.) Krog (lectotype in G! with duplicates in BM!, US!, and W!) also has a brown lower surface, fatty acid in the medulla (C–), unciform conidia, and ascospores less than 20 µm. However, it is easily differentiated by its lacinules rising from the margins of the lobes and the subtle pseudocyphellae, which are almost restricted to the amphithecium and apices of the lobules that are rare on the lamina. Additionally, *P. bolliana* has lobe margins that are frequently short-lacinulate and sparse rhizinae on the lower

surface, while *P. osorioi* has a smooth or crenate (never lacinulate) margin, and denser rhizinae that can project beyond the margins.

The tomentum-like rhizinae covering of *P. osorioi* is dense, composed of short rhizinae up to 0.95 mm, mixed with longer ones that grow up to 1.65 mm. *Punctelia tomentosula* Kurok. (holotype in TNS!), described by Kurokawa (1999), also has such dense rhizinae, but differs in presenting soralia, short-filiform conidia (7–9 µm) and lecanoric acid in the medulla (C+ rose).

Morphologically, the new species is similar to *Punctelia purpurascens* (holotype in SP!), which has a yellowish K+ purple or pale purple pigment in the medulla in the apical areas, produces large apothecia with dark brown fissured discs and has a strongly foveolate surface, with the pseudocyphellae commonly developed on the inter-foveolar ridges, many of which are elliptic, conspicuous to the naked eye.

Elix & Johnston (1988) described *Punctelia nebulata* with pale lower surface and ascospores smaller than 20 µm. This species is distinguished from *P. osorioi* by the filiform conidia (9–11 µm), rare and inconspicuous pseudocyphellae on the lamina and absence of lacinules. In addition, the holotype of this species (CANB!) presents a rugose to strongly plicate-rugose upper surface.

This new species is named in honor of Dr. Hector Osorio, distinguished Uruguayan lichenologist who contributed much to the development of our knowledge of lichenology in the Brazilian State of Rio Grande do Sul.

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Literature cited

- Bungartz F. 2001. Analysis of lichen substances. In: http://nhc.asu.edu/lichens/lichen_info/tlc.jsp Accessed in 2009, April.
- Canêz LS. 2005. A família *Parmeliaceae* na Localidade de Fazenda da Estrela, Vacaria – RS. São Paulo. Master dissertation. Instituto de Botânica, São Paulo. 302 p.
- Canêz LS. 2009. Estudo taxonômicos em *Punctelia* (*Parmeliaceae*, *Ascomycetes* Liquenizados). Doctoral Thesis. Instituto de Botânica, São Paulo. 268 p.
- Canêz LS, Marcelli MP. 2006a. Distribuição e identificação de espécies sul-americanas de *Punctelia* Krog (*Parmeliaceae*) In: 1ª REBEL - Primeira Reunião Brasileira de Estudos Liquenológicos, Catas Altas. Anais da 1ª Reunião Brasileira de Estudos Liquenológicos. São Paulo: Instituto de Botânica 1: 27–36.

- Canêz LS, Marcelli MP. 2006b. Gêneros de *Parmeliaceae* (*Ascomycetes* Liqueenizados) na localidade de Fazenda da Estrela, Vacaria, Rio Grande do Sul, Brasil. *Caderno de Pesquisa. Série Biologia* 18: 41–95.
- Canêz LS, Marcelli MP. 2007. Two new species of *Punctelia* (*Parmeliaceae*) from Southern Brazil. *Mycotaxon* 99: 211–216.
- Culberson CE, Kristinsson H. 1970. A standardized method for the identification of lichen products. *Journal of Chromatography* 46: 85–93.
- Elix JA, Johnston J. 1988. New species in the Lichen family *Parmeliaceae* (*Ascomycotina*) from the Southern Hemisphere. *Mycotaxon* 31: 491–510.
- Huneck S, Yoshimura I. 1996. Identification of lichen substances. Springer. Berlin. 493 p.
- Jungbluth P. 2006. A família *Parmeliaceae* (fungos liquenizados) em cerrados do Estado de São Paulo, Brasil. Master Dissertation. Instituto de Botânica, São Paulo. 323 p.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of Fungi, 10th Edition. CAB International, UK, 784 p.
- Krog H. 1982. *Punctelia*, a new lichen genus in the *Parmeliaceae*. *Nordic Journal of Botany* 2: 287–292.
- Kurokawa S. 1999. Notes on *Flavopunctelia* and *Punctelia* (*Parmeliaceae*), with description of four new species. *Bulletin of the Botanic Gardens of Toyama* 4: 25–32.
- Lynge B. 1914. Die Flechten der ersten Regnellschen Expedition. Die Gattungen *Pseudoparmelia* gen. nov. und *Parmelia* Ach. *Arkiv för Botanik* 13(13): 1–172.
- Marcelli MP, Jungbluth P, Elix JA. 2009. Four new species of *Punctelia* from São Paulo State, Brazil. *Mycotaxon* 109: 49–61.

Typification of the Andean taxa of *Umbilicaria* described by William Nylander

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Abstract - The typifications of the Andean taxa *Umbilicaria dichroa*, *Umbilicaria haplocarpa*, and *Umbilicaria calvescens*, originally described by William Nylander, are discussed and lectotypes designated.

Key words – nomenclature, neotropic lichens

Introduction

William Nylander (1822–99) was born in Finland and never traveled beyond Europe. A medical doctor with a penchant for natural history, he turned to lichenology inspired by the works of Elias Fries and the brothers Tulasne. He first came to Paris to study in 1852, and after a few years as professor of botany in Helsinki (1857–63), decided to return to Paris to work on lichens at the Muséum national d'Histoire naturelle (Norrlin 1913, Ahti 1967). As a reputed expert of lichens he was trusted with the identification and description of a wealth of collections made in exotic places. In a series of works Nylander described lichens from the high Andes of South America collected in the 1840s and 1850s (Nylander 1855, 1859, 1861, 1869). Among the Andean genera he studied was a genus familiar to him from his native Finland, the genus *Umbilicaria*. This genus has a worldwide distribution and constitutes a major element in the saxicolous lichen flora of the boreal, alpine, and arctic regions. Together with *Lasallia* the genus *Umbilicaria* constitute the family *Umbilicariaceae* and the sub-order *Umbilicarinae*, part of the order *Umbilicariales* (Miadlikowska et al. 2006, Spatafora et al. 2006, Hibbett et al. 2007).

The collections studied by Nylander indicated the presence in the central high Andes of an endemic group of *Umbilicaria* species with its biogeographic center in Bolivia and Peru, and he named and described several new species and varieties (Nylander 1855, 1859, 1861, 1869). More recent investigations suggest that this endemic element extends southwards into the northern

parts of Argentina and Chile and northwards into southern Ecuador (Frey 1936b, 1949; Llano 1950, Hestmark 1997). This endemic element completely dominates the *Umbilicaria* 'flora' in the lowermost parts (ca. 2800–4400m) of the altitudinal range of the genus in Bolivia, Peru, and the northern parts of Chile and Argentina.

The type concept was not instituted for botanical nomenclature when Nylander described his Andean *Umbilicaria* species, and his protologues and references to specimens are sometimes ambiguous, sometimes changing from one paper to another. He did not in any case mark or designate particular individual thalli or collections as 'type' or 'original' or something similar. This has led to much confusion, a situation that did not substantially change with Llano's monograph of the family *Umbilicariaceae* in the Western Hemisphere (Llano 1950). Llano did not visit or examine specimens from Nylander's own herbarium (H-NYL, now in H) but relied on photographs of select specimens from H-NYL. He did not at all study specimens in the cryptogamic division of the Muséum national d'Histoire naturelle (PC), despite the fact that Nylander mainly worked with the lichen collections of PC.

The aim of the present paper is to clarify the typification of Nylander's endemic Andean taxa, and designate lectotypes for the species. The study is based on all relevant material in H-NYL and PC. All specimens cited have been examined by the author.

Nomenclature

Umbilicaria dichroa

The first taxon described by Nylander in the endemic Andean element was *Umbilicaria dichroa* from Peru (Nylander 1855: 674). The protologue is brief:

"1757. *Umbilicaria dichroa* Nyl. - Affinis *U. hirsutae* var. *murinae*, sed apothecia diversa. Thallus supra cinereus opacus infra ater scaber, apothecia non plicata; sporae 4-8-nae ellipsoideae simplices, longit. 0,016-20 mm., crassit. 0,009-10 mm. - In Peruvia."

The new taxon was described from collections made by German pharmacist, botanist, and explorer Willibald Lechler (1814–56), who went to South America in 1850–55, and from April to September 1854 collected around Lake Titicaca. Lechler became Dr. sci. nat. at Tübingen in 1856; the same year he died at sea outside Ecuador on his return to Peru where he was going to take a position as physician at Arequipa (Anonymous 1858, Lehmann 1951). The plants Lechler collected in Peru were distributed and sold by the physician, missionary, and botanist Rudolf Friedrich Hohenacker (1798–1874) as *Plantae peruvianae* (on Hohenacker, see Baur 1969). The number 1757 in the protologue of *U. dichroa* refers to Lechler's collection number. Apparently no text was issued with the *Plantae peruvianae*, and thus it is not considered a published exsiccate (Sayre 1974: 356–357).

In Nylander's herbarium in H there is a specimen of this collection: H-NYL 31526, labeled "W. Lechler pl. peruvian. Ed. R. F. Hohenacker. 1757. *Umbilicaria dichroa* Nyl. Azangaro. Hoch Peru. Jun. m. 1854" and containing a single thallus, 6 cm in diameter, with a few small, scattered, leiodisc apothecia. The label further has a red-ink double-cross to indicate Nylander's chemical tests. The collection was thus made in mid-June in 1854 at Azangaro in Peru. Azángaro is both a town and a province in the Departamento Puno in Peru, on the northwestern shore of Lake Titicaca and its surrounding country to the west and north. Llano (1950: 62, 242, and Plate 11, Fig. 2) indicates H-NYL 31526 as 'Type', based on a photograph of the specimen he received from H. Presumably because he did not actually have the specimen at hand, the envelope or label of H-NYL 31526 are not marked by Llano in any way to indicate type status. Nor did Nylander mark it to indicate that it is a new species. Llano (1950: 242, and Plate 11, Fig. 1) further designated a FH collection of *Plantae peruvianae* 1757 as 'cotype', basing his *U. dichroa* description on his examination (cf. Llano 1950: 63).

Several problems relate to the Llano typifications. Frey (1931: 101) stated that he had studied a *U. dichroa* specimen from the Herb. Boissier (Bot. Institute of Geneva) and that "Die Genfer Pflanze ist das Original: Lechler, *Plantae peruviansis* [sic] no. 1757." ("The Geneva plant is the original: Lechler, *Plantae peruviansis* no. 1757."). This might be considered a typification except that (as noted in Hestmark 2007) Frey's meaning for 'Original' is ambiguous and not synonymous with 'type specimen.' His remark here is best interpreted as indicating 'original material' or 'original collection.' In any case, G holds two separate envelopes labeled as "*U. dichroa*, Lechler, *Plant. peruvianae* no. 1757" (now labeled G00053128 and G00053129) with BOTH envelopes bearing a red label marked TYPUS. Packet G00053128, which derives from herb. Duby 1886 and Müller Argoviensis 1896, contains one large (9 cm diam.) thallus lacking apothecia and three fragments glued onto the cardboard, one with abundant, well-developed leiodisc apothecia and another very parasitized. Packet G00053129 contains a single large thallus with no apothecia. It is not known who attached the TYPUS labels. In UPS there is an envelope (Lechler, *Plant. peruvianae* no. 1757) containing several *U. dichroa* fragments originally from the Thore Fries herbarium bearing a red label glued to the sheet marked COTYPUS. These examples show the confusion created by Nylander's reference to a collection number rather than a particular specimen (individual thallus) or herbarium and clearly indicate the need for a more definite designation of the *U. dichroa* type.

Nylander in the protologue did not indicate a particular specimen of *Plant. peruv. 1757*, nor a particular herbarium. In PC there are two separate sheets with specimens of *Plant. peruv. 1757*. One sheet with a big, curled-up thallus plus a

small thallus fragment with abundant leiodisc apothecia. The other sheet has several larger thallus fragments without apothecia, and a small fragment with leiodisc apothecia. The handwritten labels on BOTH these sheets, in Nylander's hand, states that they are "Nyl. n.sp. ipse"; thus they were both available to Nylander when he described the new taxon *U. dichroa*, and on the labels he actually indicated that it was a new species. It would then seem reasonable to choose one of these specimens in PC as lectotype. However, both these collections in PC seem to be *mixtures* of two species: the small apothecium bearing thallus fragments glued on to these sheets (and several other samples of Plant. peruv. 1757 in other herbaria), are evidently broken from one or a few larger thalli rich in apothecia. Some of these apothecium rich fragments have a light lower side with pale rhizinomorphs, and not the granular, reticulate black lower side of the big thalli in the Plant. peruv. 1757 collections. These small fragments are referable to the taxon *U. haplocarpa*, rather than *U. dichroa*. These two rather similar looking taxa sometimes grow in mixtures in the Lake Titicaca area (own observations), and as apothecia on *U. dichroa* are rare, it will have been tempting to distribute fragments of an apothecium-rich thallus to as many specimens of Plant. peruv. 1757 as possible.

In contrast to these often mixed collections, the single thallus of *U. dichroa* constituting H-NYL 31526 (in H) both has the characteristic black, granular lower side and a few large and several small distinctly leiodisc apothecia. It is further the single specimen of *U. dichroa* and Plant. peruv. 1757 that Nylander selected for his own private herbarium. This is the specimen stated to be the 'type' by Llano (Llano 1950: 62, 242, and Plate 11, Fig. 2). In view of the problems relating to the many other separate exemplars of Plant. peruv. 1757, I here suggest that Llano's choice of specimen should be retained, and formally designated as lectotype, while the mixture of species in some other exemplars of Plant. peruv. 1757, suggests that labels such as 'cotype' or 'isotype' should be avoided. Thus: **Lectotype (designated here)** of *Umbilicaria dichroa* Nyl. the entire collection: Herbarium Nylander (H-NYL) 31526 (in Herbarium Universitas Helsinkiensis, H). The envelope is now marked: "Lectotype of *Umbilicaria dichroa* Nyl. G. Hestmark 2008."

Umbilicaria haplocarpa

Llano (1950: 63) noted that: "Nylander's type description for *U. dichroa* and the closely related *U. haplocarpa* are very similar; without adequate cotype material for direct comparison it would have been difficult to separate undetermined specimens." In 1858 Nylander cites the nomen nudum "*U. haplocarpa* Nyl. – Peruv." (Nylander 1858: 108), and a year later describes this new species with leiodisc apothecia from the central Andes (Nylander 1859: 217):

“5. *U. haplocarpa* Nyl. - Thallus cinereus majusculus sat firmus opacus, subtus concolor vel paullo obscurior rhizinis concoloribus copiosis hirtus; apothecia superficialia simplicia plana aut convexa intus extusque nigra; sporæ sæpius 6^{næ} dilute fuscae ellipsoideæ vel oblongæ, uni-septatæ (vel adhuc septis binis longitudinalibus divisæ), long. 0,016-20, crass. 0,009-0,013 millim., paraphyses discretæ. Gelatina hymenea iodo cærulescens, dein violaceæ obscurata. - In Peruvia lecta a cel. Cl. Gay. - Convenit hæc species externa facie omnino cum *U. hirsuta*, at apothecia abunde differunt.”

The only collection cited in this protologue is one made in Peru by French botanist and historian Claude Gay Mouret (Claudio Gay; 1800–73), famous for his multi-volume *Historia física y política de Chile*, where several volumes treat botany. Gay traveled in South America in 1828–32, and 1834–42, and made a trip to Peru in 1839–40. On this trip he crossed the Cordillera from Lima via the Tingo Pass to Cuzco, visiting Tarma, Huancavelica, Ayacucho, Andahuaylas, Abancay and Arequipa (Gay Mouret 1843, Stuardo Ortiz 1973: 305-307). Accordingly a collection by Gay must be the type, if it can be traced. Nylander does not indicate in which herbarium the Gay collection of *U. haplocarpa* is to be found. Llano in his treatment of *U. haplocarpa* explicitly stated that “Type or cotype material leg. Gay was not seen.” (Llano 1950: 65). He nevertheless wrote: “Type: In the Nylander Herb, Botanical Museum, University of Helsingfors, from Peruviae montibus, leg cl. Gay (Pl. 10, fig. 1-3)” (Llano 1950: 64). But in fact there is no Gay collection of *U. haplocarpa* in H-NYL or H, and the figure Llano refers to (Llano Pl.10, fig. 1-3), Figs. 1 and 2 are of the dorsal and ventral side of the collection No. 5487 made by I.M. Lamb, from Argentina; while Fig. 3 is a photograph of the specimen H-NYL 31527. In the figure text (Llano 1950: 240), this specimen is described as “Fig. 3. *Agyrophora haplocarpa* (Nyl.) Llano. Bolivia, Puna Peguas, leg. Mandon. Nylander Herb. No. 31527. TYPE (H). Dorsal surface with apothecia; ventral surface showing slightly in lower left hand corner.” Thus Llano here makes ANOTHER typification, this time a specimen collected by Mandon. This specimen (H-NYL 31527) is indeed present in H-NYL, and was collected by French plant collector Gilbert Mandon (1799–1866), who in the 1850s was manager of the mine Tipuani in the village of Sorata by the mountain Illampu in Bolivia and returned to France in 1861 (Weddell 1867). The handwritten label says “*Umbilicaria haplocarpa* Nyl. Bolivia, Puna Peguas. Mandon.” It is NOT collected by Gay, NOT in Peru, and is clearly not the specimen cited in the protologue of *U. haplocarpa*. Because Mandon returned to France with his collections in 1861, when Nylander devoted a separate paper to their description (Nylander 1861), it seems unlikely that Mandon specimens were at all available when he wrote the protologue of *U. haplocarpa*.

The collections by Gay examined by Nylander all belong to PC, and had been deposited there several years before Nylander started his work in Paris. Thus he was not at liberty to take out one or a few thalli for his own private herbarium the way he usually did when receiving new collections for determination.

In PC there is a single collection by Gay of *U. haplocarpa*, marked with printed letters: “PÉROU. (1839-1840.) M. Cl. GAY.” The sheet is marked by Nylander’s hand with *Umbilicaria haplocarpa*, and the small envelope/capsule is marked similarly by Nylander. There is no mark indicating that this is a type specimen, or that it is a new species. A small, square piece of paper attached inside the envelope carries the number “645”, possibly an indication of Gay’s collection number. The collection consists of a single specimen, with a few leiodisc apothecia, and a lower side richly covered with rhizinomorphs. Some of the apothecia are convex as indicated in the protologue. The thallus has a hole in the middle, probably due to Nylander’s extraction of some apothecia for microscopic examination. The specimen also appears to be attacked by parasitic fungi. Except for the leiodisc apothecia, the specimen is, as noted in the protologue, quite similar to the taxon *Umbilicaria hirsuta*, a species with gyrose apothecia. The specimen has slightly soresiate margins. The latter characteristic, as well as the rather few apothecia unfortunately makes it a not very typical specimen of the taxon. Although it seems likely that this is the Gay specimen Nylander examined when he described *U. haplocarpa*, it cannot be proven that this is the one specimen used by the author, or designated by the author as the nomenclatural type (cf. McNeill et al. 2006, Article 9.1). Thus it cannot definitely be identified as the holotype. But as it is the only identifiable specimen of a Gay collection, labeled by Nylander *Umbilicaria haplocarpa*, it ought to be considered the nomenclatural type, in this case a lectotype.

Lectotype (designated here) of *Umbilicaria haplocarpa* Nyl. The entire collection: cryptogamic Herbarium, Muséum national d’Histoire naturelle, Paris (PC): Thallus in envelope marked *Umbilicaria haplocarpa* Nyl. in William Nylander’s handwriting, glued on small sheet marked “PÉROU. (1839-1840.) M. Cl. GAY.”, glued onto larger sheet marked “HERB._MUS. PARIS.” in print and *Umbilicaria haplocarpa* Nyl. in William Nylander’s handwriting. The sheet is now also marked with a label: “Lectotype *Umbilicaria haplocarpa* Nyl. Designated by G. Hestmark 2008.”

Umbilicaria calvescens

Umbilicaria calvescens was first published as a nomen nudum by Nylander (1860: 418): “*U. calvescens* Nyl. in Mus. Par. – Peruv., Boliv.”, and placed in the sub-group or section “*Stirps Umbilicariae velleae*.” Taxonomic confusion started already in this first announcement by Nylander listing two varieties, both nomen nuda, collected in two different countries: var. *subvellea* Nyl. – Bolivia, and var. *hypomelaena* Nyl. – Peruvia. (Lechl. Nr. 2704). The name of the latter (Greek *hypo*, ‘under’ and *melas*, ‘dark’ or ‘black’) quite probably refers to a dark or black lower side of the thallus. The name ‘subvelleus’ might alternatively mean ‘somewhat hairy’ or ‘hairy below.’ The only identifiable

collection here is for the var. *hypomelaena*, again a collection made by Willibald Lechler, distributed by Hohenacker in the *Plantae peruviana*, and originally (and erroneously) identified as *Umbilicaria vellea* by Nylander (1855: 674).

The first published description of *U. calvescens* appeared in Nylander (1861: 375), a paper examining lichen collections made by French plant collector Gilbert Mandon mentioned above:

“*Umbilicaria calvescens* Nyl. Syn. II, p.8, t.9, f.5. – Affinis *U. velleæ*, sed minor et sporis singularibus nonnihil difformibus medioque constrictiusculis (longit. 0^{mm},015-20, crassit. 0^{mm},008-0^{mm},012). – Ad rupes in regione alpina.”

No particular collection is indicated here. In Nylander's treatment of Mandon's collections, no varieties are listed, and the description is really only a statement about how this taxon is similar to *U. vellea*, but also differs in size and ascospore form. The reference to the second volume of Nylander's *Synopsis Lichenum* does, however, indicate that Nylander himself considered the description and illustration in his *Synopsis Lichenum* to be the first description of *U. calvescens*, hence the protologue of the species. He evidently thought *Synopsis Lichenum* II would be published before or at the same time as the paper. The first volume of *Synopsis Lichenum* appeared in 1860 but the publication date of the second volume has remained enigmatic (Norrlin 1913: 37–38, Ahti 1990). The fact that Nylander in 1861 was able to cite both the correct page number and the figure number on the plate, does however indicate that proofs or even ready prints were at hand. Norrlin (1913: 38) suggests that the first four sheets of the second volume of *Synopsis Lichenum* were indeed printed shortly after the publication of volume one, which appeared in 1860. However, because 1869 was indicated as publication date for volume two in Renvall (1891), presumably based on information from Nylander himself, Norrlin (1913) and also TL-2/6945 has accepted 1869 as the year of publication. In *Synopsis Lichenum* the description reads:

“*U. calvescens* Nyl. in Mus. Paris. Similis *velleæ*, sed thallo cinereo-fuscente subtus subnudo vel fibrillis rhizineis parvis, apotheciis gyrosis, sporis incoloribus (vel dilute fascis) ellipsoideis sæpe medio constrictiusculis (longit. 0,012-16 millim., crassit. 0,008-9 millimi.). In Boliviae provincial Yungas lecta a cel. Weddell, in Peruvia a cl. Cl. Gay. Forte nonnisi varietas *velleæ*, sed sporis convenit cum iis (simplicibus) *Umbilicariæ haplocarpæ*; variant quoque sporæ nonnihil difformes. Gelatina hymenea iodo vinose violacee tincta, præcedente cærulescentia. Thallus latitudinis 1-3-pollicaris, varians vel subtus cinereo-pallescent vel fuscens. Variat idem passim magis rhizinosus vel subtus hirsutus (var. *subvellea*). – Variat dein, var. *hypomelaena*, subtus nigricans rhizinis concoloribus (Lehl. Pl. Peruv. No 2704); pagina infera ei subpapillosa (comparanda *papillosa*, quæ vix a *spodochroa* differt). TABULA IX, fig. 5: *a* theca et *b* sporæ, aucta diametris 275.”

Here we have references to collections made by Weddell, Gay and Lechler, as well as an institution: the Paris museum. But no mention of Mandon. The proofs of this part of the second volume of *Synopsis Lichenum* were thus in all

probability completed before Nylander examined Mandon's collections in 1861, and wrote what is formally the protologue. (The Plate IX of *Synopsis Lichenum* referred to by Nylander, had however not been printed, as it is in fact labelled "Tab. I" in the printed *Synopsis Lichenum* Vol.2, and not "IX"). On this plate the Fig 5a and b depict an ascus and three separate ascospores.

This complicated publication story gives rise to two questions. First: can we identify a type specimen for *U. calvescens*? Secondly, how should the two varieties listed by Nylander be interpreted – as deviations from the type, or one of them as incorporating the type? These questions should, if possible, be solved with reference to the material in PC and/or H-NYL clearly available to Nylander when he wrote the protologue.

TYPE OF *U. CALVESCENS*—The protologue of *U. calvescens* is the one in Nylander (1861: 375), a paper treating collections by Mandon. Must we then choose a specimen collected by Mandon as lectotype? The description in Nylander's *Synopsis Lichenum* cited in the protologue shows that he had several collections in PC by other collectors than Mandon at hand when he formed his conception of *U. calvescens*, indeed that it had been formed before he received the Mandon collection, because there is no reference to Mandon material in the description of *U. calvescens* in *Synopsis Lichenum* II, only to specimens by Weddell, Gay (and Lechler for the var. *hypomelaena*).

The ICBN (McNeill et al. 2006: Art. 9.2) stipulates that a lectotype should be selected from material available to the author when the description validating the name was published. In the present case this implies collections by Weddell, Gay and Mandon available to Nylander at the time of the publication of Nylander (1861). Given Nylander's specification in *Synopsis Lichenum* II of locality to the Paris Museum, it seems appropriate to seek a lectotype for *U. calvescens* in PC. However, Llano (1950: 178, 258, Pl. 19, figs. 2-3) stated the collection H-NYL 31531 (in H) to be the type of *U. calvescens*, claiming that "Nylander placed his sign for type on specimen No. 31532. [sic; should be 31531, GH note]" (Llano 1950: 179), and "marked by Nylander with a plus sign (+) for TYPE" (Llano 1950: 258). However, the red-ink cross markings refer to different chemical tests performed by Nylander (cf. Hue 1892, and T. Ahti personal communication), and have nothing to do with typification. Thus Llano's typification was based on an error, a chemical test interpreted as a sign for type. And again he did not consider material in PC. It can nevertheless be argued that this is a typification based on original material available to Nylander, and should for this reason be considered valid. What kind of type is another question. The concepts of holotype, lectotype etc. were not in formal use in 1950. The brown envelope containing H-NYL 31531 was in 1992 labeled by J. Wei "Lectotype of *Umbilicaria calvescens* Nyl.", but this has not been published.

The locality and collector of this collection is given on the tiny white envelope inside as “Bolivia, Yungas, Weddell.” It contains three small thalli, from 20 to 25 mm in diameter. All thalli have abundant black, gyrose apothecia on their uniformly smooth, grey-brown upper surface. Two of the thalli have scattered tiny rhizinomorphs. The third thallus, has a slightly trabeculate lower side and no rhizinomorphs. The entire collection comes close to the primary characteristic given in Nylander’s description: “subtus subnudo vel fibrillis rhizineis parceis” – the lower side almost naked or with sparingly rhizinomorphs – the feature that probably made him decide for the name *calvescens* (‘balding’) in the first place. Furthermore, the spore measurements written by Nylander on the tiny white envelope within the brown envelope corresponds exactly to those given for *U. calvescens* in Synopsis Lichenum. Thus this collection by Weddell, which Nylander selected for his own personal herbarium, is probably the one he used when describing the typical *U. calvescens*. A similar Weddell collection in PC, consisting of five thalli, does not have spore measurements written on it, and the two Gay collections in PC labeled *U. calvescens* by Nylander, are of poor quality. Llano (1950, Pl. 19, figs. 2-3) depicts the upper side of one of the thalli in H-NYL 31531, and the lower side of one of the other thalli in the collection. There are three thalli in H-NYL 31531, and together they give a good impression of the typical variety of the taxon *U. calvescens*. As McNeill et al. (2006: Art. 8.2) allows for the typification of a species on multiple small plants, it seems appropriate in this case, as done by Llano, to consider the entire collection the type collection. As the current ICBN does not provide unambiguous rules or advice to decide whether the typification made by Llano should be considered valid, a **lectotype** of *Umbilicaria calvescens* Nyl. is **here designated**: The entire collection: Herbarium Nylander (H-NYL) 31531 (in Herbarium Universitatis Helsinkiensis, H). The envelope is now also marked: “Lectotype *Umbilicaria calvescens* Nyl., designated by Hestmark 2008.”

VARIETY—*UMBILICARIA CALVESCENS* VAR. *HYPOMELAENA*. For the variety *hypomelaena* Nylander explicitly indicates a collection and a collector (Lechler Plantae peruvianae No. 2704) different from Weddell and Gay mentioned in the general description in Synopsis Lichenum. This clearly indicate that this is not a typical *U. calvescens*. In PC there are two sheets with Lechler/Hohenacker No. 2704: one with two small thalli only marked *Umbilicaria vellea*, and another sheet with specimens from the same collection with a small note in the lower right corner by Nylander “*Umbilicaria calvescens* var. *hypomelaena*.” In Nylander’s herbarium in Helsinki there is a specimen (H-NYL 31533), with his handwriting: “*Umbilicaria calvescens* Nyl. var. *subtus nigricans* Peruvia. Lechler 2704.” Inside the envelope is a cardboard with a paper slip glued on to it, with the text: “W. Lechler pl. peruvian. Ed. Th. F. Hohenacker. 2704. *Umbilicaria vellea* Fr. Sachapata ad saxa gran. Sept. 54.” There is further a double-cross in

red indicating chemical reactions, and some notes in on ascospore sizes and a small drawing of three unicellular, ellipsoid, hyaline ascospores. On the other side of the paper slip is a single cross in red, indicating chemical tests. This specimen is depicted in Llano 1950, Pl. 20, Fig. 4-5. In the figure text to Fig. 4 here Llano (1950: 260) states that it is “*Umbilicaria calvescens* Nyl., var. *nigricans* Nyl. Peru. W. Lechler Pl. Peruvian. No. 2704. Nylander Herb. No. 31533, marked by Nylander with a plus sign (+) for TYPE. (H). Dorsal surface with apothecia.” Because Llano stated another specimen to be the type of *U. calvescens* (see above) this seems to be intended as a type indication for the variety *nigricans*. There are several problems here. One is that Nylander did not himself recognize a var. *nigricans* – this was a preliminary name he annotated to specimens he published as the var. *hypomelaena*. As Llano (1950: 179) correctly states that the var. *hypomelaena* is based on Lechler No. 2704, and explicitly refers this variety to the specimen depicted in Pl. 20, Figs. 4-5, his figure text with var. *nigricans* may be regarded as a slip. More serious is Llano’s misconception of typification by Nylander, mistaking the sign for chemical tests for a sign of type.

Because Nylander originally distinguished the var. *hypomelaena*, and this deviates significantly from typical specimens of *U. calvescens*, a typification for this variety is desirable. And as one of the PC specimens of Lechler/Hohenacker No. 2704 is the only one actually annotated var. *hypomelaena* by Nylander, but cannot be definitely identified as a holotype, this seems to be the best choice for a: **Lectotype (designated here)** of *Umbilicaria calvescens* var. *hypomelaena* Nyl.: the entire collection: cryptogamic Herbarium, Muséum national d’Histoire naturelle, Paris (PC), envelope now labeled “Lectotype of *Umbilicaria calvescens* var. *hypomelaena*. Designated by G. Hestmark 2008.” Mounted on small carton marked “W. Lechler pl. peruvian. Ed. Th. F. Hohenacker. 2704. *Umbilicaria vellea* Fr. – Nyl. Sachapata ad saxa granitica Sept. m. 54”, mounted on sheet marked “HERB. MUS. PARIS. *Umbilicaria calvescens* var. *hypomelaena* Nyl.”

VARIETY—*UMBILICARIA CALVESCENS* VAR. *SUBVELLEA*. That the var. *subvellea* is also not to be considered a typical *U. calvescens* is indicated by the contrast of the two names: *subvellea* (hairy below) versus *calvescens* (balding), and the description in Synopsis Lichenum of var. *subvellea* as “subtus hirsutus” (lower side hirsute/hairy). Of the many collections of *U. calvescens* in PC annotated by Nylander, only a single sheet is annotated *subvellea*, in Nylander’s handwriting: “*Umbilicaria calvescens* var. *subvellea* Nyl.” The sheet has a glued on printed label with the text: “AMERIQ: MERID. Répub. de BOLIVIA. Prov. de YUNGAS. Décemb. 1846. M.H. Alg. WEDDELL. No.” and then in Nylander’s handwriting “*Umbilicaria vellea* Fr. similis *U. calvescens* Nyl. var. *subvellea*.” The text from ‘similis...’ is apparently a later addition; the collection was first identified as *U. vellea*. The specimen has small gyrose apothecia and a dense cover of rhizinomorphs on the lower side. British born botanist and physician Hugh

Algernon Weddell (1819–77) travelled in Bolivia, Brazil and Peru from 1843 to 1848 and subsequently worked as aide-naturaliste at the Muséum d'Histoire naturelle in Paris 1850–57. In H-NYL there are no specimens of *U. calvescens* annotated var. *subvellea*. Llano (1950: 179) nevertheless states H-NYL 31507 to be var. *subvellea*, but this is not indicated anywhere on the collection, and H-NYL 31507 in fact seems closer to the var. *hypomelaena*. H-NYL 31507 was collected by Mandon who returned to France in 1861, and the collection was thus probably not available to Nylander when he formed his conception of the var. *subvellea* in 1860. As the var. *subvellea* exemplifies one extreme of the variation within *U. calvescens* with regard to the lower cortex cover of rhizinomorphs, and this extreme is the opposite of that of the typicum, it seems desirable to designate a type. But as Nylander has not clearly identified a type, a lectotypification seems appropriate:

Lectotype of *U. calvescens* var. *subvellea* here designated: the entire collection: cryptogamic Herbarium, Muséum national d'Histoire naturelle, Paris (PC), envelope now labeled “Lectotype of *Umbilicaria calvescens* var. *subvellea*. Designated by G. Hestmark 2008.” On the sheet, below the envelope, in Nylander's handwriting: “*Umbilicaria vellea* Fr. similis *U. calvescens* Nyl. var. *subvellea*.” On sheet, lower right corner, glued on printed label marked “AMERIQ: MERID. Répub. de BOLIVIA. Prov. de YUNGAS. Décemb. 1846. M.H. Alg. WEDDELL. No.”

Acknowledgements

The author wishes to thank professors and curators at the Botanical Museum, Helsinki, Teuvo Ahti, Katileena Lohtander, Soili Steenroos, Orvo Vitikainen, as well as Curator Bruno Denetiere at the Musée National d'Histoire Naturelle, Paris, for their kind help. Arve Elvebakk (Tromsø University) and Per Magnus Jørgensen (BG) are thanked for their valuable comments on this paper.

Literature cited

- Ahti T. 1990. Introduction to Collected Lichenological Papers of William Nylander (1822-1899). In: Ahti T. (ed.) William Nylander's Collected Lichenological Papers, Vol. 1. J. Cramer: Berlin. pp. VIII–XXIV.
- Anonymous 1858. Personal-Notiz. Lechler. Botanische Zeitung 16: 62–64.
- Baur K. 1969. Dr. Rudolf Friedrich Hohenacker (1798–1874). Jahreshefte der Gesellschaft für Naturkunde in Württemberg 124: 146–156.
- Frey E. 1931. Weitere Beiträge zur Kenntnis der Umbilicariaceen. Hedwigia 71: 94–119.
- Frey E. 1936a. Vorarbeiten zu einer Monographie der Umbilicariaceen. Berichte der Schweizerische Botanischen Gesellschaft 45: 198–230 + Taf. 10–13.
- Frey E. 1936b. Die geographische Verbreitung der Umbilicariaceen und einiger alpiner Flechten. Berichte der Schweizerische Botanische Gesellschaft 46: 412–444.

- Frey E. 1949. Neue Beiträge zu einer Monographie des Genus *Umbilicaria* Hoffm., Nyl. Berichte der Schweizerischen Botanischen Gesellschaft 59: 427–470.
- Gay Mouret C. 1843. Fragment d'un Voyage dans le Chili et au Cusco, Patrie des anciens Incas. Bulletin de la Société de Géographie, 2 Ser., 19: 15–7.
- Hestmark G. 1997. Species diversity and reproductive strategies in the family Umbilicariaceae on high equatorial mountains – with remarks on global patterns. Bibliotheca Lichenologica 68: 195–202.
- Hestmark G. 2007. Typification of *Umbilicaria cinereorufescens*. Mycotaxon 100: 235–240.
- Hibbett DS, Binder M, Bischoff JF, Blackwell M, Cannon PF, Eriksson O, Huhndorf S, James T, Kirk PM, Lücking R, Lumbsch T, Lutzoni F, Matheny PB, McLaughlin DJ, Powell M., Redhead S, Schoch CL, Spatafora JW, Stalpers JA, Vilgalys R, Aime MC, Aptroot A, Bauer R, Begerow D, Benny GL, Castlebury LA, Crous PW, Dai YC, Gams W, Geiser DM, Griffith GW, Gueidan C, Hawksworth DL, Hestmark G, Hosaka K, Humber RA, Hyde K, Koljalg U, Kurtzman CP, Larsson KH, Lichtwardt R, Longcore J, Miadlikowska J, Miller A, Moncalvo JM, Mozley-Standridge S, Oberwinkler F, Parmasto E, Reeb V, Rogers JD, Roux C, Ryvarden L, Sampaio JP, Schüssler A, Sugiyama J, Thorn RG, Tibell L, Untereiner WA, Walker C, Wang Z, Weir A, Weiss M, White M, Winka K, Yao YJ, Zhang N. 2007. A higher-level phylogenetic classification of the Fungi. Mycological Research 111: 509–547.
- Hue AM. 1892. Lichenes exotici a Professore W. Nylander descripti vel recogniti et in Herbario Musei Parisiensis pro maxime parte asservati in ordine systematico dispositi sunt. E.G. Masson, Paris.
- Lehmann E. 1951. Schwäbische Apotheker und Apothekergeschlechter in ihrer Beziehung zur Botanik. Lothar Hempe Verlag: Stuttgart.
- Llano GA. 1950. A Monograph of the Lichen Family Umbilicariaceae in the Western Hemisphere. Navexos P-831. Office of Naval Res. Dep. Navy: Washington, D.C.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. Regnum Vegetabile 146. 568 p.
- Miadlikowska J, Kauff F, Hofstetter V, Fraker E, Grube M, Reeb V, Hestmark G, Hodgkinson B, Kukwa M, Garcia Ojalora M, Rauhut A, Scheidegger C, Timdal E, Stenroos S, Brodo I, Ertz D, Diederich P, Lücking R, Lendemer JC, Tripp E, Yahr R, May P, Perlmutter G, Hillis DM, Buck WR, Gueidan C, Arnold AE, Martinez I, Robertson C, Hafellner J, Lutzoni F. 2006. New insights into classification and evolution of the *Lecanoromycetes* (*Pezizomycotina*, *Ascomycota*) from phylogenetic analyses of three ribosomal RNA- and two protein-coding genes. Mycologia 98: 1088–1103.
- Norrin JP. 1913. Minnesord öfver professor William Nylander. Acta Soc Sci. Fennica 44: 1–43.
- Nylander W. 1855. Südamerikanische Flechten, gesammelt durch W. Lechler, bestimmt durch Dr. W. Nylander. Flora 43: 673–675.
- Nylander W. 1858. Énumération Générale des Lichens, avec l'indication sommaire de leur distribution géographique. Mémoire Société Sciences Naturelles de Cherbourg 5: 85–146.
- Nylander W. 1859. Lichenes in regionibus exoticis quibusdam vigentes. Exponit synopticis enumerationibus Wilhelm Nylander. Annal. Sci. Nat., Bot., sér. 4, 11: 205–264.
- Nylander W. 1860. Conspectus *Umbilicariarum*. Exponit breviter. Flora 43: 417–418.
- Nylander W. 1861. Additamentum ad Lichenographiam Andium Boliviensium. Annal. Sci. Nat., Bot., sér. 4, 15: 365–382.
- Nylander W. 1869. Synopsis methodica *Lichenum* omnium hucusque cognitorum præmissa introductione lingua gallica tractata. Paris. Vol. 2, Trib. XIV. Gyrophorei. pp. 3–20.

- Renvall RA. 1891. Finlands Universitet 1828-1890. Biografiska uppgifter öfver dess lärare, embets- och tjänstmän. Andra upplagen. Helsingfors. Pp. 269-273.
- Sayre G. 1975. Cryptogamae exsiccatae. An annotated bibliography of exsiccatae of algae, lichens, hepaticae and music. V. Unpublished exsiccatae. I. Collectors. Memoirs of the New York Botanical Garden 19(3): 277–423.
- Spatafora JW, Johnson D, Sung GH, Hosaka K, O'Rourke B, Serdani M, Spotts R, Lutzoni F, Hofstetter V, Fraker E, Gueidan C, Miadlikowska J, Reeb V, Lumbsch T, Lücking R, Schmitt I, Aptroot A, Roux C, Miller A, Geiser D, Hafellner J, Hestmark G, Arnold AE, Büdel B, Rauhut A, Hewitt D, Untereiner W, Cole MS, Scheidegger C, Schultz M, Sipman H, Schoch C. 2006. A five-gene phylogenetic analysis of the Pezizomycotina. Mycologia 98: 1018–1028.
- Stuardo Ortiz C. 1973. Vida de Claudio Gay: Escritos y documentos. Vol. 1. Santiago de Chile : Editorial Nascimento.
- Weddell HA. 1867. Notice sur M.G. Mandon. Bulletin de la Société Botanique de France 14: 10–12.

A new lichen, *Melanohalea subexasperata* (Parmeliaceae), from the Tibetan Plateau

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Abstract — A new *Melanohalea* species characterized by the presence of cortical hairs, *M. subexasperata*, is described from the Tibetan Plateau.

Keywords — Asia, China, lichenized fungi, taxonomy

Introduction

The lichen genera *Melanohalea* O. Blanco et al. and *Melanelixia* O. Blanco et al. in the *Parmeliaceae* were segregated from *Melanelia* Essl. based on molecular as well as chemical and morphological data (Blanco et al. 2004). *Melanohalea* is characterized by common pseudocyphellae, often on warts or isidial tips, and by a medulla containing depsidones or lacking secondary compounds (Blanco et al. 2004, Esslinger 1977). *Melanelixia* is characterized by often lacking pseudocyphellae and by containing lecanoric acid as the primary medullary constituent (Blanco et al. 2004, Esslinger 1977). Worldwide, *Melanelixia* includes nine known species, *Melanohalea* twenty species, and *Melanelia* still contains a heterogeneous residue of seventeen species (Esslinger 1977, 1978, 1987, 1992; Ahti et al. 1987, Egan 1987, Galloway & Jørgensen 1990, Thell 1995, Divakar et al. 2001, 2003; Blanco et al. 2004, Divakar & Upreti 2005, Wang et al. 2008).

Cortical hair is a very important taxonomic character in the brown parmelioid lichens. Produced by five *Melanelixia* species and three *Melanelia*

*Equal corresponding authors

species, the cortical hairs are lacking in all known *Melanohalea* species (Wang et al. 2008, 2009). However, during our study of the lichen flora of the Tibetan Plateau, an interesting *Melanohalea* species with cortical hairs new to science was found.

Materials and methods

The specimens studied were collected from the Tibetan Plateau, China, and are preserved in SDNU (Lichen Section of Botanical Herbarium, Shandong Normal University) and HKAS (Herbarium of Cryptogams, Kunming Institute of Botany Academia Sinica). The morphology of the lichen specimens was examined using a stereo microscope (COIC XTL7045B2) and a microscope (OLYMPUS CX21). Lichen substances in all specimens cited were identified using the standardized thin layer chromatography techniques (Culberson 1972). Photos of the thallus and cortical hairs were taken under OLYMPUS SZX12 with DP70 and OLYMPUS BX69.

Taxonomic description

Melanohalea subexasperata F.G. Meng & H.Y. Wang, sp. nov.

FIG. 1

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Melanohalea subexasperata tomentis corticibus a congeneribus diversa.

TYPE COLLECTION: CHINA. Yunnan province, Shangri-la, Tianshengqiao, alt. 3500m, on twigs, H.Y. Wang, 20084032, 3 November 2008. (Holotype in SDNU).

DESCRIPTION — Thallus foliose, appressed throughout, adnate, 1.5–10 cm in diameter. Lobes 0.2–2 mm broad, 75–100 µm thick, flat, short, and slightly elongate, discrete to more often contiguous or subimbricate. Upper surface dark olive-brown, shiny at lobe ends, inward becoming dull; occasionally lightly pruinose, bearing small, hyaline cortical hairs, especially on the apothecial margins; without soredia, isidia or lobules, but with numerous, evenly scattered, conical to short-cylindrical papillae, each bearing a conspicuous pseudocyphella at the tip. Lower surface black, often paler at the margin; smooth to wrinkled, dull to slightly shiny; moderately rhizinate, the rhizines simple, concolorous with the lower surface, to 1mm long. Apothecia common, sessile to short stipitate, concave to flattening, mostly 2 mm in diameter; margin very soon developing pseudocyphellate papillae, nearly always bearing cortical hairs, often with rhizines; hymenium 30–45 µm thick, subhymenium 10–20 µm thick; spores 8, globose to ellipsoid, 8–10 × 6–8 µm, spore wall 1 µm thick. Pycnidia rare; conidia 7–8 × 1 µm, acerose to weakly fusiform.

CHEMISTRY — Cortex K–, HNO₃–; medulla C–, K–, KC–, PD–; Constituents (8 specimens tested): no substances detected.

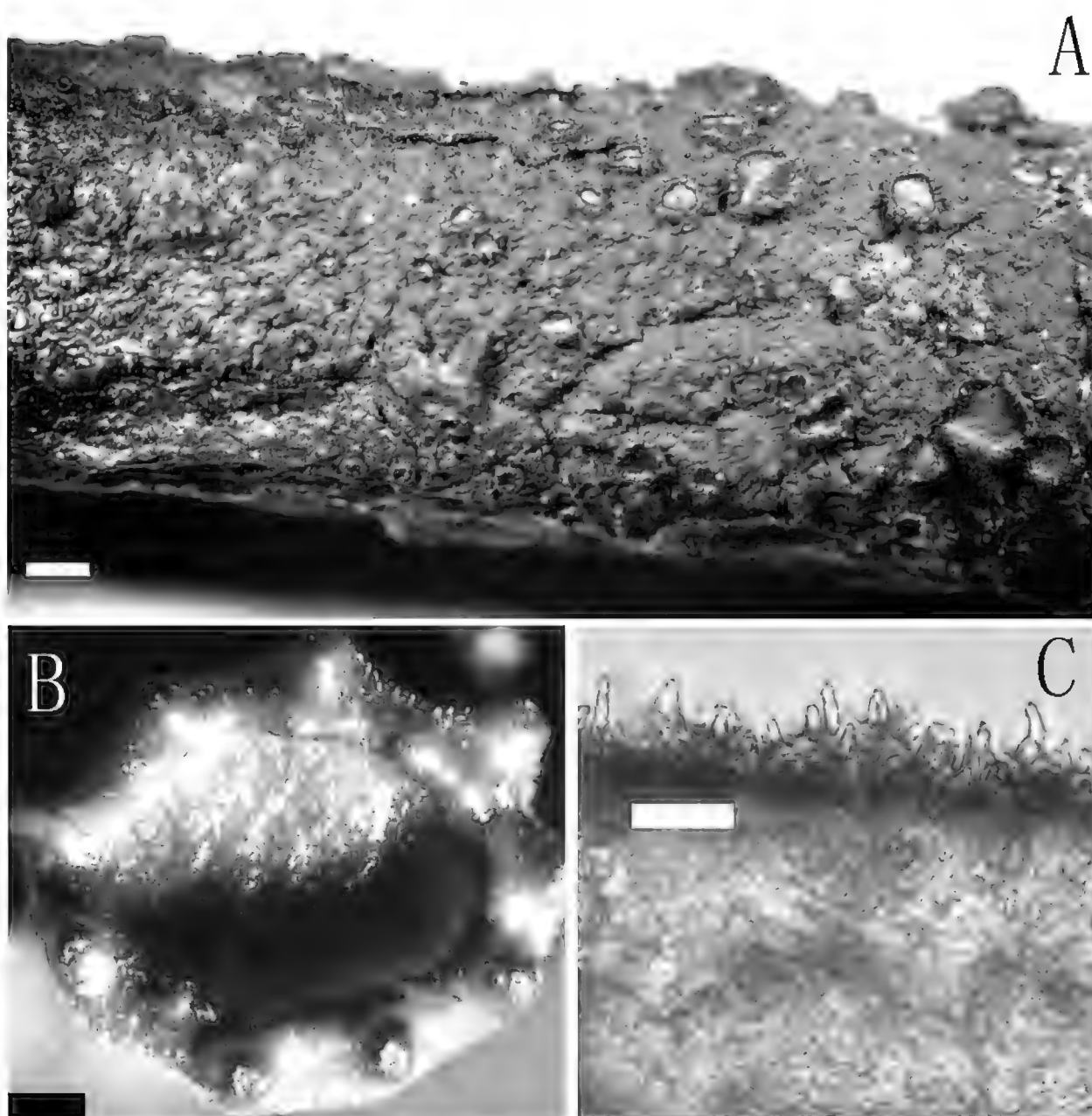


FIG. 1 Photographs of the holotype of *Melanohalea subexasperata*.
A. thallus (bar = 1mm). B. & C. showing cortical hairs on the apothecial margin
(B: bar = 100µm; C: bar = 20µm).

DISTRIBUTION AND SUBSTRATE — *Melanohalea subexasperata* is a corticolous species, found in the southeast of the Tibetan Plateau at elevations of 2700–3500m.

SPECIMENS EXAMINED —CHINA. YUNNAN: Shangri-la Co. TIANSHENGQIAO, alt. 3500m, on twigs, 3/xi/2008, H.Y. Wang 20084031, 20084032, 20084033, 20084034 (SDNU); BITAHAI, alt. 3500m, on twigs, 21/x/1994, L.S. Wang 9414984, 9415513 (HKAS); SICHUAN: Kangding Co. PAOMASHAN alt. 2700m, on twigs, 3/xi/2008, H.Y. Wang 20084076, 20084078 (SDNU).

COMMENTS —The presence of cortical hairs distinguishes *Melanohalea subexasperata* from all other *Melanohalea* species. A total of eight brown

parmeloid lichens have cortical hairs. They are *Melanelixia albertana*, *M. subargentifera*, *M. glabra*, *M. villosella*, *M. subvillosella*, *Melanelia fuscosorediata*, *M. piliferella*, and *M. pseudoglabra*. *Melanelixia* species all contain lecanoric acid, while the three *Melanelia* species with cortical hairs all contain gyrophoric acid. The molecular systematics indicates *Melanelia* species containing gyrophoric acid probably belong to *Melanelixia* (Wang et al. 2009), suggesting that all known species with cortical hairs are closely related. However, the lack of lichen substance and the presence of conspicuous pseudocyphella suggest *M. subexasperata* is the member of *Melanohalea* rather than *Melanelixia*. Furthermore, *Melanohalea subexasperata* closely resembles *Melanohalea exasperata* (De Not.) O. Blanco et al., which also has evenly scattered, conical, pseudocyphellate papillae and lacks soredia, isidia, lobules, and lichen substances. Although *M. subexasperata* is certainly related to *M. exasperata*, the former can be clearly separated from the latter by smaller lobes (0.2–2 mm vs. 1–6 mm broad), the thicker hymenium (twice the thickness of the subhymenium), and, of course, the presence rather than absence of cortical hairs. Except for *M. subexasperata*, *M. septentrionalis* (Lyngé) O. Blanco et al. is the only known *Melanohalea* species where the hymenium is obviously thicker than the subhymenium. *Melanohalea septentrionalis* differs from *M. subexasperata* in the presence of fumarprotocetraric and protocetraric acids (PD+ orange) and the absence of papillae.

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Literature cited

- Ahti T, Brodo IM, Noble WJ. 1987. Contributions to the lichen flora of British Columbia, Canada. *Mycotaxon* 28: 91–97.
- Blanco O, Crespo A, Divakar PK, Esslinger TL, Hawksworth DL, Lumbsch HT. 2004. *Melanelixia* and *Melanohalea*, two new genera segregated from *Melanelia* (*Parmeliaceae*) based on molecular and morphological data. *Mycological Research* 108(8): 873–884.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Divakar PK, Upreti DK, Elix JA. 2001. New species and new records in the lichen family *Parmeliaceae* (*Ascomycotina*) from India. *Mycotaxon* 80: 356–362.
- Divakar PK, Upreti DK, Sinha GP, Elix JA. 2003. New species and records in the lichen family *Parmeliaceae* (*Ascomycota*) from India. *Mycotaxon* 88: 149–154.

- Divakar PK, Upreti DK. 2005. A new species in *Melanohalea* (*Parmeliaceae*, *Ascomycotina*) and new lichen records from India. *Lichenologist* 37(6): 511–517.
- Egan RS. 1987. A fifth checklist of the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. *The Bryologist* 90(2): 77–173.
- Esslinger TL. 1977. A chemosystematic revision of the brown *Parmeliae*. *Journal of the Hattori Botanical Laboratory* 42: 1–211.
- Esslinger TL. 1978. A new status for the brown *Parmeliae*. *Mycotaxon* 7: 45–54.
- Esslinger TL. 1987. A new species of *Melanelia* from Nepal. *Mycotaxon* 28: 215–217.
- Esslinger TL. 1992. The brown *Parmelia* type specimens of A. N. Oxner. *Lichenologist* 24(1): 13–20.
- Galloway DJ, Jørgensen PM. 1990. *Bartlettiella*, a new lichen genus from New Zealand, with notes on a new species of *Melanelia* and a new chemodeme of *Bryoria indonesica* in New Zealand. *New Zealand Journal of Botany* 28: 5–12.
- Tell A. 1995. A new position of the *Cetraria commixta* group in *Melanelia* (*Ascomycotina*, *Parmeliaceae*). *Nova Hedwigia* 60(3–4): 407–422.
- Wang HY, Chen JB, Wei JC. 2008. A new species of *Melanelixia* (*Parmeliaceae*) from China. *Mycotaxon* 104: 185–188.
- Wang HY, Chen JB, Wei JC. 2009. A phylogenetic analysis of *Melanelia tominii* and four new records of brown parmelioid lichens from China. *Mycotaxon* 107: 163–173.

A new species of *Hyphoderma* (Basidiomycetes) from India

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Abstract – A new corticioid species *Hyphoderma parvispora* is described from Dalhousie hills (District Chamba) in Himachal Pradesh, India.

Key words – Banikhet, small spores

During a mycological excursion in Dalhousie hills (Himachal Pradesh, India), Dhingra and Singla made a collection on the underside of a decaying gymnospermous log. After detailed comparison of macroscopic and microscopic features with relevant literature (Dhingra 1989, Eriksson & Ryvarden 1975, Rattan 1977), it was found to be close to *Hyphoderma capitatum* J. Erikss. & Å. Strid. Characters in common were generative hyphae without clamps and clavate basidia, while cystidia in the new described species were subcylindrical to subfusiform compared with capitate cystidia in *H. capitatum*, and the basidiospores were distinctly smaller ($5.7\text{--}7.4 \times 5.1\text{--}6.2 \mu\text{m}$) compared to larger ones in the latter species ($8\text{--}11(13) \times 7\text{--}9 \mu\text{m}$). A sample of the basidiocarp was sent to Prof. Nils Hallenberg, University of Göteborg, Sweden, who supported the concept of a new species.

Hyphoderma parvispora Avneet P. Singh, Priyanka, Dhingra & Singla, sp. nov.

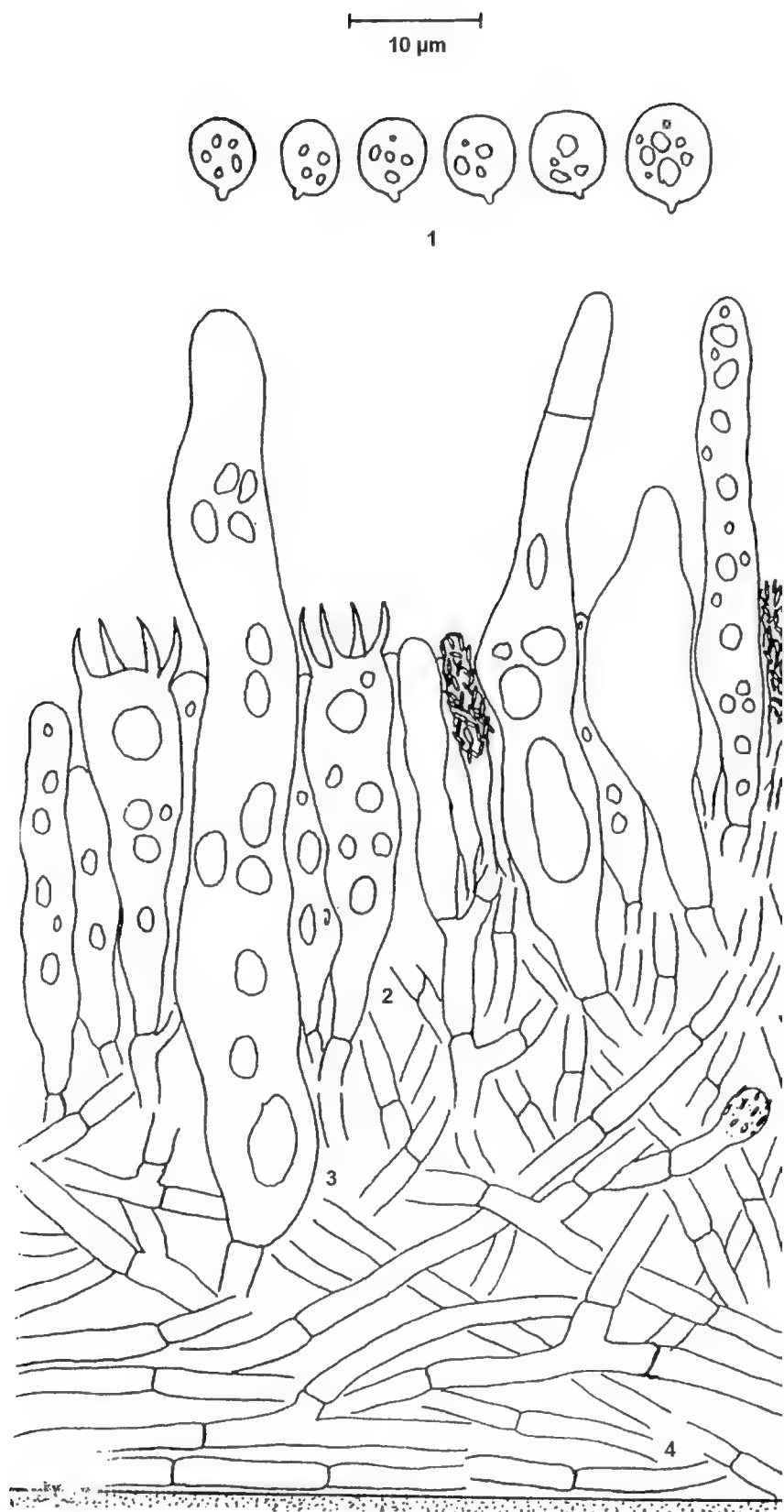
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FIGS 1–5

Basidiocarpum resupinatum, adnatum, effusum, ad 100 μm crassum; hymenium superficiei flavidum vel subflavidum, laevigatum vel tuberculatum, brunneo maculatum; systema hyphale monomiticum; hyphae ad 4 μm latae, fibulis destitutae, tenuitunicatae vel paulo crassitunicatae; cystidia 34–75 \times 5.7–9.6 μm ; subcylindrica vel subfusiformia, oleosa; basidia 25–30.6 \times 6.8–7.4 μm , clavata, 4-sterigmata, tenuitunicata vel paulo crassitunicata, fibulis destituta; basidiosporae 5.7–7.4 \times 5.1–6.2 μm , subglobosae vel globosae, laeves, tenuitunicatae vel paulo crassitunicatae, acyanophilae vel dilute cyanophilae.

TYPE: India, Himachal Pradesh: Chamba, 2 km from Dalhousie in direction to Banikhet, on decayed gymnosperm wood, Nishi 1623 (PUN, **holotype**), September 19, 1989.

ETYMOLOGY: The epithet refers to small basidiospores.



FIGS 1–4. Microscopic structures from basidiocarp of *Hyphoderma parvispora*:
1. basidiospores; 2. basidia; 3. cystidia; 4. generative hyphae.

Basidiocarps resupinate, effused, adnate, up to 100 µm thick in section; hymenial surface smooth to rough, creamish white to ochraceous; margins indeterminately thinning, paler concolorous. Hyphal system monomitic;

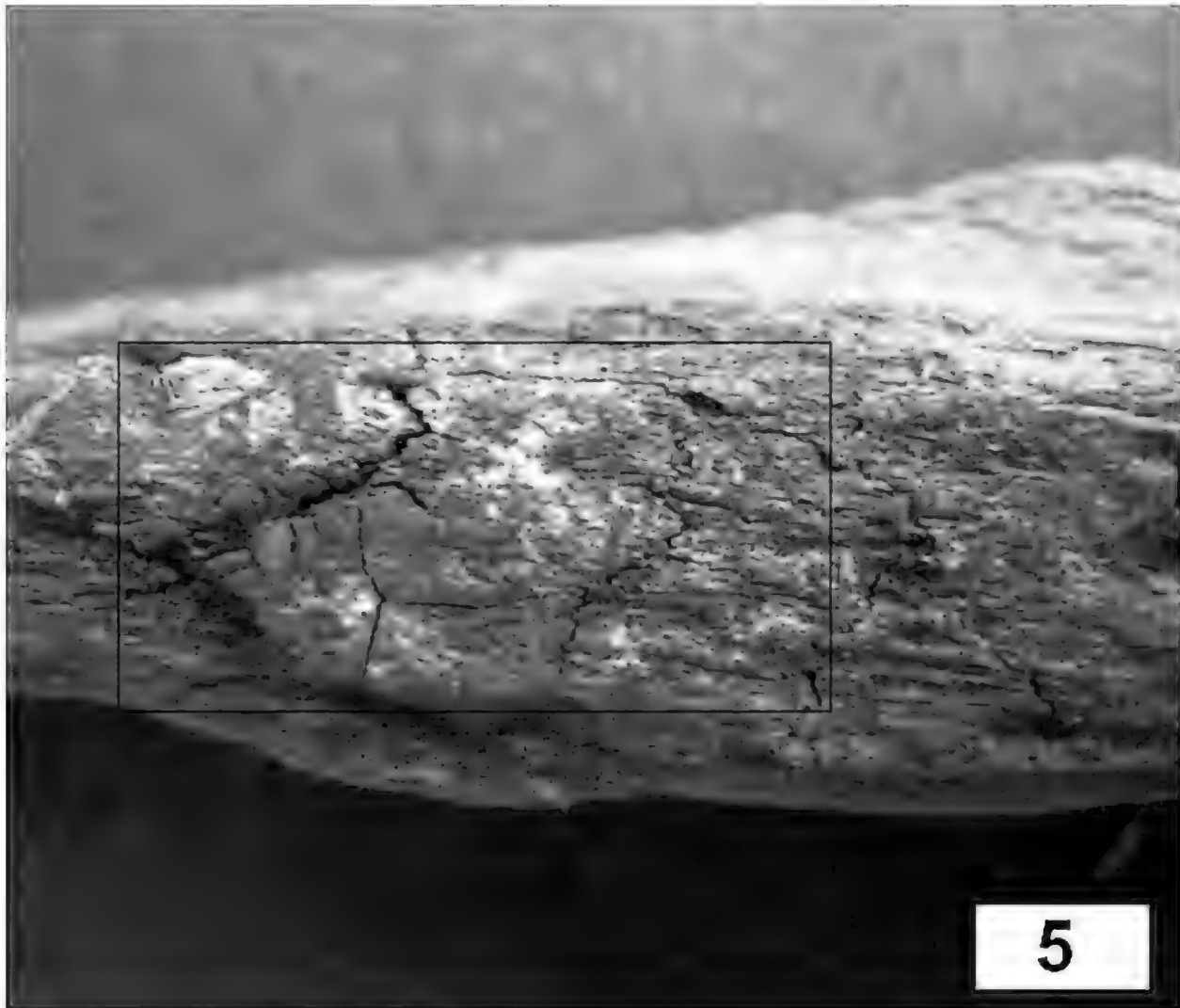


FIG. 5. *Hyphoderma parvispora* basidiocarp showing hymenial surface.

generative hyphae up to 4 μm wide, branched, septate, without clamps, thin- to somewhat thick-walled; basal hyphae running parallel to the substrate, somewhat broader than the vertical subhymenial hyphae. Cystidia 34–75 \times 5.7–9.6 μm , subcylindrical to subfusiform, with oily contents, immersed or projecting up to 15 μm out of the hymenium. Basidia 25.0–30.6 \times 6.8–7.4 μm , clavate, thin- to somewhat thick-walled, 4-sterigmate, without a basal clamp; sterigmata up to 5.1 μm long. Basidiospores 5.7–7.4 \times 5.1–6.2 μm , subglobose to globose, smooth, thin- to somewhat thick-walled, non-amyloid, acyanophilous to weakly cyanophilous, with oily contents.

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Literature cited

- Dhingra GS. 1989. Genus *Hyphoderma* Wallr. em Donk in the Eastern Himalayas. Plant Science Research in India (eds. Trivedi ML, Gill BS, Saini SS) Today & Tomorrow's printers & publishers: New Delhi, pp. 197–212.
- Eriksson J, Ryvarden L. 1975. *Corticiaceae* of North Europe – III. Oslo: 287–546.
- Rattan SS. 1977. The Resupinate *Aphylllophorales* of the North Western Himalayas. Bibliotheca Mycologica 60: 1–427.

Taxonomic position of *Mucor hiemalis* f. *luteus*

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Abstract – The taxonomic position of isolates described by Schipper in 1973 as *Mucor hiemalis* f. *luteus*, nom. inval., was reevaluated using morphological and molecular data. Based on these data, we propose to validate this taxon at specific rank, as *M. luteus*. A complete taxonomic description is given and a diagnostic signature sequence is indicated.

Key words – *Mucorales*, endophytes, phylogeny, rhizoids

Introduction

Mucor hiemalis Wehmer 1903 is the most common and the most variable species within this genus (Schipper 1973). Representatives of this species are frequent soil-borne fungi but they can also be isolated as saprotrophs or parasites from plant material and animals (Costa et al. 1990). Schipper (1973) reexamined the *M. hiemalis* complex and described *M. hiemalis* as one species with four forms: *M. hiemalis* f. *corticola* (Hagem) Schipper 1973, *M. hiemalis* Wehmer 1903 f. *hiemalis*, *M. hiemalis* f. *luteus* (Linnem.) Schipper 1973, and *M. hiemalis* f. *silvaticus* (Hagem) Schipper 1973. Although f. *luteus* is invalid because it lacks a Latin diagnosis (McNeill et al. 2006: Art. 36.1), this name is commonly used (Costa et al. 1990). The taxon has also been treated at specific rank (e.g. Mehorta et al. 1966, Zycha et al. 1969, Pei 2000), either as *M. luteus* Linnem. 1936 (nom. inval.; McNeill et al. 2006: Art. 36.1) or as *M. luteus* Linnem. ex K.Q. Pei 2000 (nom. inval.; McNeill et al. 2006: Art. 37.1). *Mucor hiemalis* is a representative of the polyphyletic genus *Mucor* (O'Donnell et al. 2001), which comprises about 50 species (Zycha et al. 1969, Schipper 1978a, Mehrotra & Mehrotra 1978, Mirza et al. 1979, Subrahmanyam 1983, Chen & Zheng 1986, Schipper & Samson 1994, Watanabe 1994, Zalar et al. 1997, Kirk et al. 2008). Furthermore, *M. hiemalis* does not form a monophyletic clade with *M. mucedo*, the type species of the genus, which suggests that *M. hiemalis* should not be classified within the genus *Mucor* (O'Donnell et al. 2001).

Moreover, some studies employing molecular data (Voigt et al. 1999) revealed that some *Rhizomucor* species form a clade with *M. hiemalis*. The morphological traits diagnostic for representatives of *Rhizomucor* genus are: presence of irregular rhizoids and stolons as in the fungi of genus *Rhizopus*, a sympodially branched sporangiophore, and a well visible collar as in some members of *Mucor racemosus* group (Lucet & Costantin 1900). The genus *Rhizomucor* as monographed by Schipper (1978b) comprised three thermophilic species, all pathogenic to humans: *R. miehei* (Cooney & R. Emers.) Schipper 1978, *R. tauricus* (Milko & Schkur.) Schipper 1978, and *R. pusillus* (Lindt) Schipper 1978. Four new *Rhizomucor* taxa have been added since 1978: *R. pakistanicus* M. Qureshi & J.H. Mirza 1979, *R. endophyticus* R.Y. Zheng & H. Jiang 1995, *R. variabilis* var. *regularior* R.Y. Zheng & G.Q. Chen 1993, and *R. variabilis* R.Y. Zheng & G.Q. Chen 1991 var. *variabilis*. Among them *R. endophyticus* and *R. variabilis* are not thermophilic, which is an exception in the genus (Zheng & Jiang 1995). *Rhizomucor endophyticus* was isolated as an endophyte from leaves of *Triticum aestivum* L., and its ITS sequence is available in GenBank (EF583635). Although both *R. variabilis* varieties were described as human primary cutaneous mucormycosis-causing species (Zheng & Cheng 1991, 1993), descriptions of sequences recorded in GenBank suggest that they could also be found in soil (EU327189) or in plants (EU196747). Voigt et al. (1999) have already demonstrated the polyphyly of *Rhizomucor*. The two thermophilic species — *R. pusillus* and *R. miehei* — form a clade closely related to *Thermomucor indicae-seudaticae* Subrahm. et al. 1977, *Mycocladius blakesleeanus* (Lendn.) J.H. Mirza 1979, and *Mycocladius corymbifer* (Cohn) Váňová 1990, while the mesophilic *R. variabilis* and *R. endophyticus* form a clade with *M. hiemalis* (Voigt et al. 1999).

Recently, new strains forming rhizoid-like structures were isolated from healthy gametophytes of *Sphagnum magellanicum* Brid. and sporophytes of *Huperzia selago* (L.) Bernh. ex Schrank & Mart. in Poland. The aim of the present study was to evaluate the taxonomic position of these isolates, using morphological observations and sequences of ITS and SSU rDNA.

Materials and methods

Fungal strains and culture condition

Fungal strains were isolated from healthy sporophytes of *H. selago* and gametophytes of *S. magellanicum*. Plants were subsequently surface sterilized according to the protocols of Szypuła et al. (2005). Plant explants were incubated on potato-dextrose agar (PDA) for 2 weeks from which pure cultures were established. Reference strains of isolated fungi are maintained in the Herbarium Generale Universitatis Varsoviensis (WA00000017113 and WA0000009410), Warsaw, Poland and in the Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands (CBS 124075).

Light microscopy observations

Strains were studied on 2% PDA medium. The hyphae and sporulating structures were mounted in lactophenol mounting medium (Amann's fluid; Russell 1974) and measured using a light microscope (Nikon Eclipse – 600, Tokyo, Japan). Digital images were recorded with a Nikon DX 1200 camera.

DNA isolation, amplification and sequencing

Total genomic DNA was extracted from fresh mycelium grown on PDA plates using a Plant DNasy Extraction Kit (Qiagen, Inc. Valencia, California). The internal transcribed spacer region (ITS; ca. 0.5 kb) and 18S rDNA (SSU rDNA; ca. 1.8 kb) were amplified via PCR. Forward primers ITS1-f, ITS5 and reverse primers ITS4, LR3 were used to amplify the ITS region (Gardens & Bruns 1993). Forward primers nssu97a, nssu131 and reverse primer nssu1088 were used to amplify SSU rDNA (Kauff & Lutzoni 2002). PCR and sequencing protocols followed Kornilowicz-Kowalska et al. (2006). Forward and reversed sequences were using BioEdit Sequence Alignment Editor v. 7.0.0 (Hall 1999).

Phylogenetic analysis

Pairwise and global alignments of the ITS and 18S rDNA regions were performed in BioEdit Sequence Alignment Editor v. 7.0.0 (Hall 1999). Phylogenetic trees were obtained from the data using maximum parsimony (MP) in PAUP* v. 4.0b10 (Swofford 2002) and Bayesian analysis (BA) in MrBayes v. 3.1.2 (Huelsenbeck & Ronquist 2001). Tree robustness was evaluated by 10000 replicate bootstrap analysis. The Akaike Information Criterion (AIC) implemented in Modeltest 3.7 (Posada & Crandall 1998) was used to select the model that best fit each data set. BLAST (Basic Local Alignment Search Tool) searches in GenBank with ITS region sequences were performed using the blastn algorithm. For phylogenetic analysis *Mortierella alpina* (EF519911, EF519912) for the ITS data set and *Mortierella verticillata* (AF157145) for the 18S rDNA data set were used as outgroups. GenBank accession numbers used in these studies are indicated on the phylogenetic trees.

DNA barcoding

The hairpin loop 2 (L2) of the ITS2 fragment is a variable and specific fragment of DNA that can be used for species identification in fungi (Landis & Gargas 2007). The ITS2 fragment of isolate CBS 124075 was found using the ITS2-Database (Selig et al. 2008; Eddy 1998). The RNA folding structure was determined using Mfold program (Zuker & Stiegler 1981) on the DINAMelt server (Markham & Zuker 2005) and RNAfold web server (Hofacker et al. 1994). The output files were aligned and the sequence of L2 was determined using the BioEdit Sequence Alignment Editor v. 7.0.0 (Hall 1999). The accuracy of characteristic sequence identification was verified using the BLAST algorithm against the whole GenBank database.

Results

Morphological observations

Morphological characters are presented in TABLE 1 and are compared with other closely related species. They are also presented in the taxonomic description.

TABLE 1. Comparison of morphological characters between *Mucor hiemalis* and *Rhizomucor* species.

	THERMO- PHILIC	RHIZOIDS	COLONY COLOR	SPORANGIOPHORE BRANCHING	SPORANGIA COLOR	SPORANGIAL DIAMETERS (µm)	COLUMELLAE	SPORANGIOSPORE SHAPE	SPORANGIOSPORE DIMENSIONS (µm)
<i>Mucor hiemalis</i> f. <i>luteus</i>	-	+	marguerite yellow	sympodial	yellowish	31.5–50.5 (SD 9.5 µm)	globose	narrow ellipsoidal	4.6–7.4 (SD 1.4) × 1.1–2.9 (SD 0.9)
<i>Mucor hiemalis</i> f. <i>luteus</i>	-	+	marguerite yellow	sympodial	yellowish	26.5–53.5 (SD 13.5 µm)	globose	narrow ellipsoidal	4.4–8.2 (SD 1.9) × 1.9–3.5 (SD 0.8)
<i>Rhizomucor</i> <i>endophyticus</i>	-	+	dark gray to blackish	sympodial	dark brown	38–80	globose, subglobose	variable	3–16 × 2–8
<i>Rhizomucor</i> <i>variabilis</i>	-	+	whitish to ochraceous	simple (once branched)	nd	≤ 100	spherical, ellipsoidal to cylindrical	variable	3–11 × 2–7
<i>Rhizomucor</i> <i>pusillus</i>	+	+	brownish	combined monopodial- sympodial	gray	≤ 80	obovoidal to slightly pyriform	subglobose	3–4
<i>Rhizomucor</i> <i>miehei</i>	+	+	pale olive gray	sympodial	brownish	≤ 60	spherical to subspherical	subspherical to ellipsoidal	3–4
<i>Rhizomucor</i> <i>tauricus</i>	+	+	pale olive gray	unbranched or weakly sympodial	gray	≤ 125	globose to obovoid	subglobose	3–4
<i>Mucor hiemalis</i> f. <i>hiemalis</i>	-	-	pale olive gray	sympodial	brownish	≤ 70	globose	ellipsoidal	≤ 9.5
<i>Mucor hiemalis</i> f. <i>corticola</i>	-	-	pale olive gray	sympodial	brownish	≤ 70	globose	cylindrical- ellipsoidal	≤ 9.5
<i>Mucor hiemalis</i> f. <i>silvaticus</i>	-	-	pale olive gray	sympodial	gray	≤ 70	globose	cylindrical	≤ 9.5

Phylogenetic analysis

The SSU rDNA dataset contained 32 taxa and 1829 characters, including gaps. 631 characters were parsimony informative. The ITS rDNA dataset contained 43 taxa and 657 characters, including gaps. 473 characters were parsimony informative. The topologies of trees obtained using MP and BA were very similar or even identical in respect to all *Rhizomucor* branches. The highest support values were obtained using BA (Figs 1 and 2).

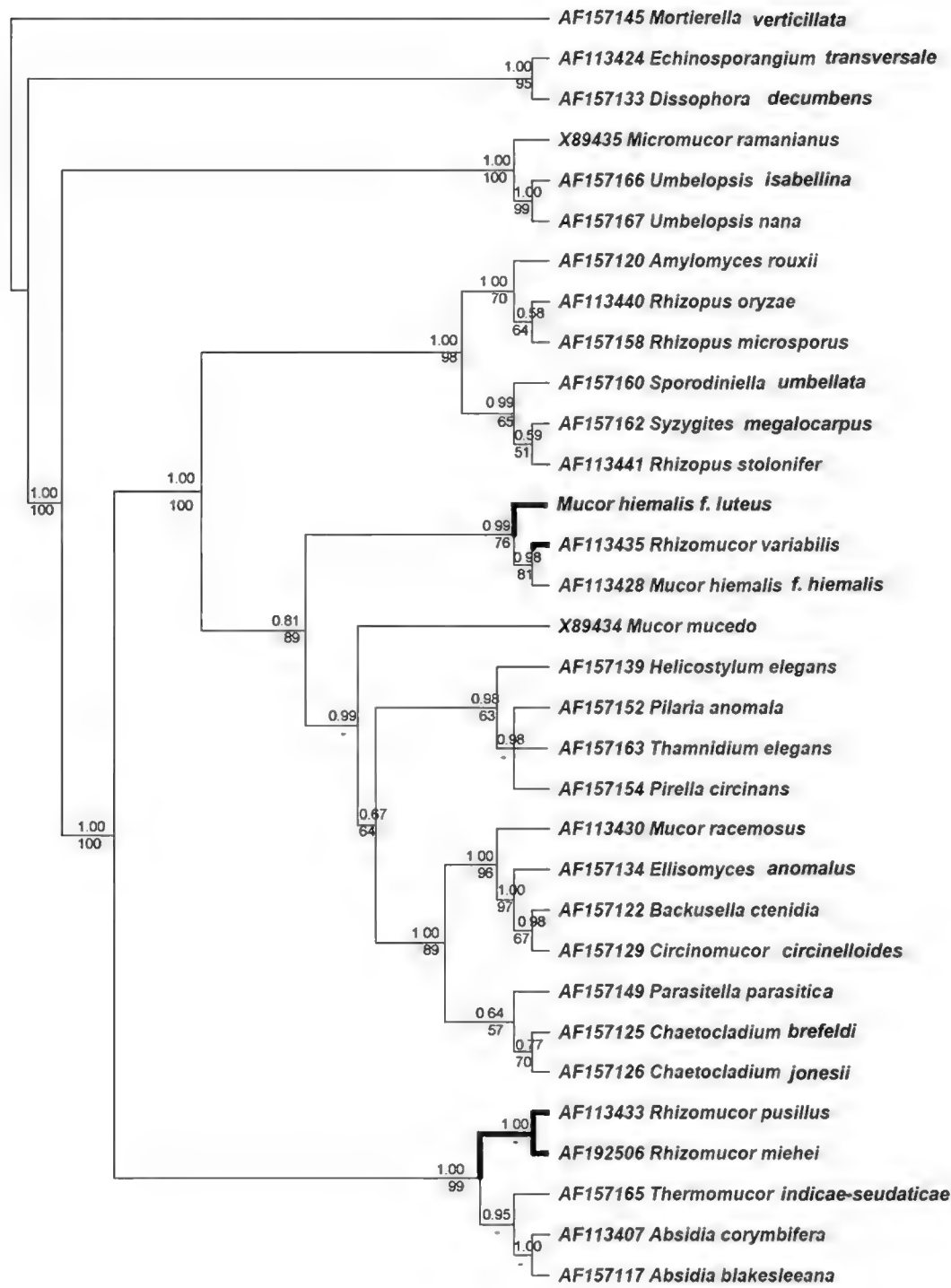


FIG. 1. Majority rule consensus tree based on Bayesian analysis of SSU rDNA data for *Mucorales*. Numbers above branches indicate Bayesian posterior probability values; numbers under branches indicate bootstrap values inferred by maximum parsimony analysis. Branches shown with black, bold lines indicate rhizoid-forming species.

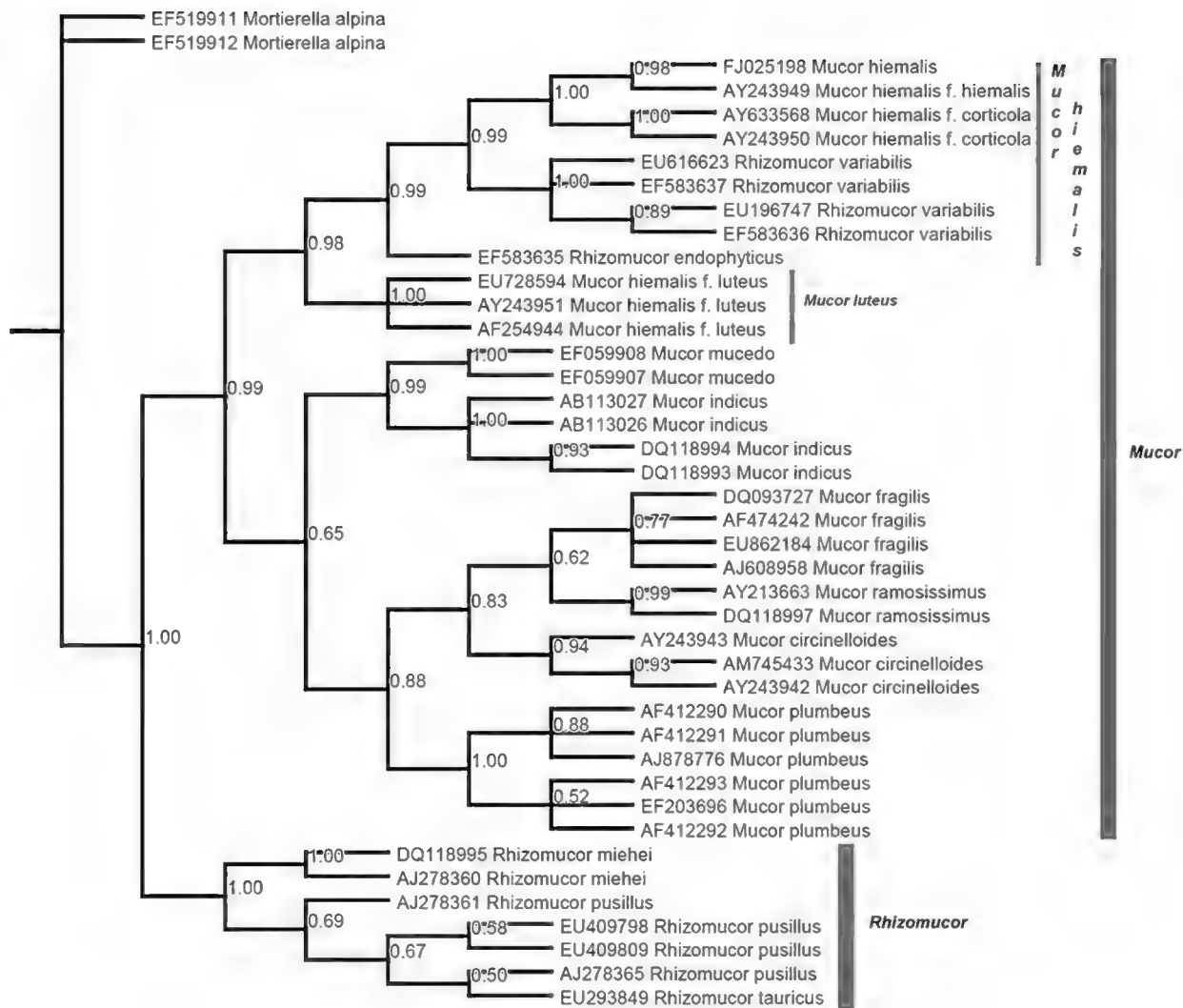


FIG. 2. Majority rule consensus tree based on Bayesian analysis of ITS1, 5.8S rDNA, ITS2 data for *Mucor* and *Rhizomucor* genus. Numbers at nodes indicate Bayesian posterior probability values.

The ITS sequence of CBS 124075 strain revealed the highest similarity to *Mucor hiemalis* f. *luteus* (AY243951; e value = 0.0; maximum identity = 99%). And the SSU sequence of this isolate revealed the highest similarity to *M. hiemalis* f. *hiemalis* (AF113428 and *Rhizomucor variabilis* AF113435; e value = 0.0; maximum identity = 98% both). It is the second record of this taxon in Poland (Kwaśna 1997).

Our results confirmed the polyphyly of the *Rhizomucor* genus (Voigt 1999, O'Donnell et al. 2001) and placing *Rhizomucor variabilis* among the different *Mucor hiemalis* formae (FIG. 1). Thus, we decided to see whether other rhizoid-forming strains could be found within the *M. hiemalis* clade. The ITS fragment analysis confirmed that two species described after critical revision of *Rhizomucor* genus (Schipper 1978b) are in fact located among representatives of *Mucor hiemalis*.

CBS strain 124075 is placed within the *M. hiemalis* f. *luteus* clade, outgroup to all other isolates within the *M. hiemalis* clade in SSU and ITS analyses. Taking into account the presence of a specific, well-defined signature sequence within the ITS2 L2, low ITS sequence similarity to other *M. hiemalis* representatives (less than 90%) and distinct morphological characters, this taxon should be treated as a separate species, *Mucor luteus*.

Taxonomic description

Mucor luteus Linnem. ex Wrzosek, sp. nov.

PLATE 1

MYCOBANK MB 515300

“*Mucor luteus*” Linnem., Flora 130: 195. 1936, nom. inval. (ICBN [Vienna] Art. 36.1).

“*Mucor hiemalis* f. *luteus*” Schipper, Stud. Mycol. 4: 33. 1973,
nom. inval. (ICBN [Vienna] Art. 36.1).

“*Mucor luteus*” Linnem. ex K.Q. Pei, Mycosystema 19(1): 10.
2000, nom. inval. (ICBN [Vienna] Art. 37.1).

Coloniae in PDA ad temp 17°C lutae vel subalbae, reverso simile colorato; hyphis in substrata radicularibus, in hyphis sterylus fasciculis minoris cum ramis singularis, sporangiophora (100–)500–2000(–3000) µm alta, erecta, (3–)5–11(–15) µm diam., symplicia, raro sympodice ramosa; sporangia globosa, lutea, (10–)30–50(–70) µm diam.; parietibus deliquescentibus, columellae globosae vel obovoideae, collaribus plerumque parvis sed distinctis; sporangiosporae hyalinae, ellipsoideae, variabiles in magnitudine, (3–)4–7(–13) × (0.5–)1–3(–5) µm. A species differret a ordinatione L2 ITS2 rDNA sequenti: GAGAAGTTCCACCTTGGTGGATTTCTT.

TYPE: mating type (-), Marburg, Germany, G. Linnemann, Centraalbureau voor Schimmelcultures CBS 243.35 (holotype: lyophilised culture)

SIGNATURE SEQUENCE: ITS2 L2: 5' GAGAAGTTCCACCTTGGTGGAT-TTCTT 3'

ETYMOLOGY: from colony color

Colonies grow rapidly on PDA medium with an optimum growth temperature of 17°C. Colonies marguerite yellow (Ridgway 1912). Colony reverse is baryta yellow (Ridgway, 1912). Vegetative hyphae is nonseptate and (3–)5–11(–15) µm in diameter. Stolons and abundant variously shaped rhizoids may be present. Most rhizoids were found on vegetative hyphae or stolons, but they were also present on sporangiophores. Sporangiophores (100–)500–2000(–3000) µm in length, rarely singly sympodially branched. Sporangia globose, yellowish, (10–)30–50(–70) µm in diameter, transparent walls that leave a visible collar. Columellae regularly globose. Sporangiospores narrow ellipsoidal, smooth walled, colorless, relatively small and variable in dimensions (3–)4–7(–13) × (0.5–)1–3(–5) µm.

SPECIMENS EXAMINED: – GERMANY, HESSEN: Marburg, G. Linnemann, ex-holotype Malt Extract Agar culture CBS 243.35 – POLAND, PODLASKIE: Mikaszówka, Augustów Primeval Forest (53°53'18"N, 23°24'45"E; WGS84 system) from healthy gametophytes of *S. magellanicum*, 22 Oct 2008, J. Budziszewska, CBS 124075.

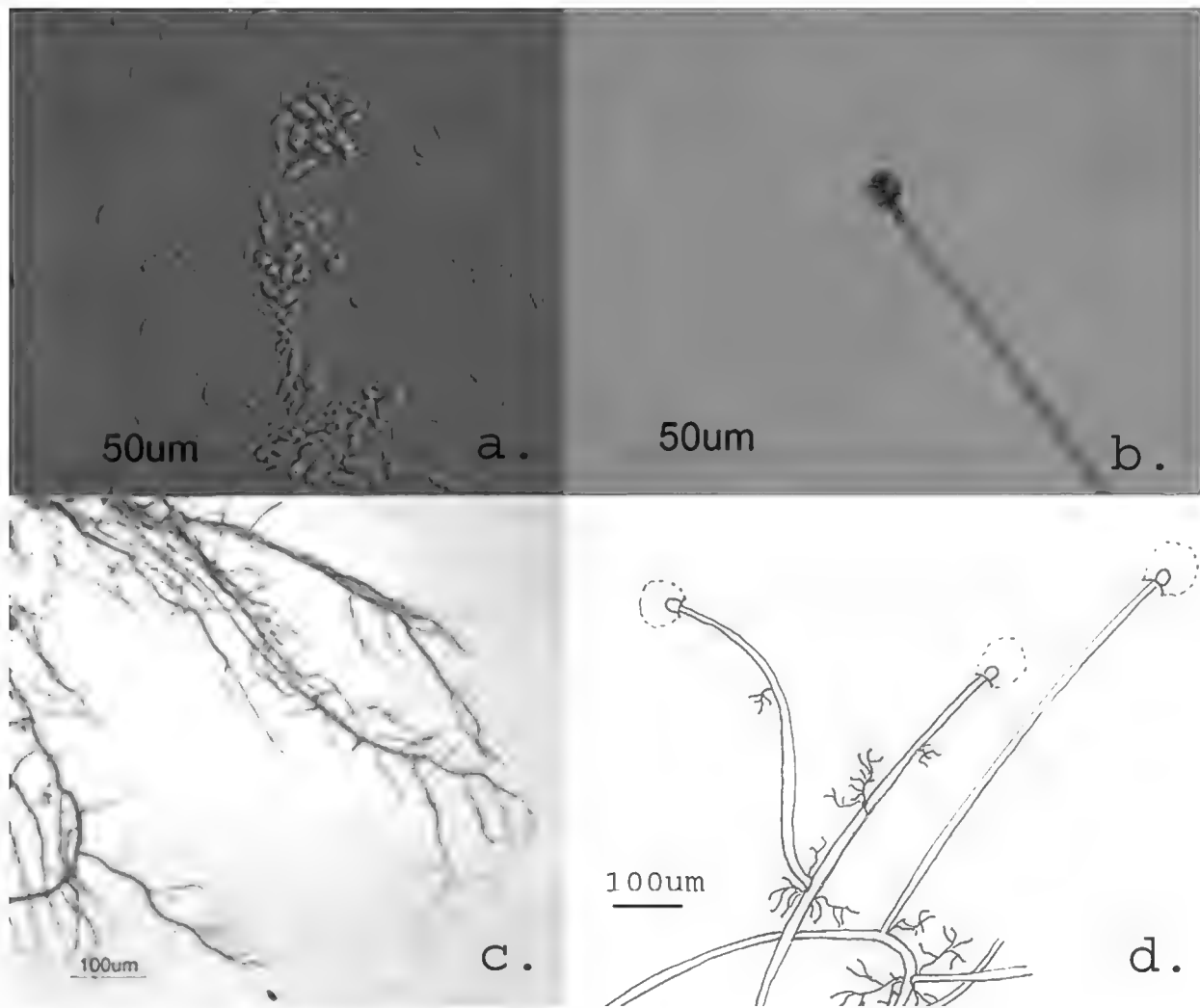


PLATE 1. *Mucor luteus*:

a. sporangiospores; b. globose columellae; c. rhizoid-like structures; d. general aspect.

Discussion

Schipper (1973) reported that *Mucor hiemalis* f. *luteus* formed short horizontal sterile branches (spine-like) on the aerial hyphae. Thus the rhizoids observed in strain CBS 124075 (but also in *Rhizomucor endophyticus* and *R. variabilis*) could represent a kind of such excessively well-developed sterile branches. Moreover our observations on the designated type of *M. hiemalis* f. *luteus* (CBS 243.35) revealed that it also produced rhizoids. Our results indicate that the presence of these rhizoids is not a good character for delimiting *Rhizomucor* and *Mucor*, as rhizoids appear independently in these taxa and may be related with a pathogenic or endophytic life style. The *M. luteus* and *R. endophyticus* rhizoids may be well adapted to invade plants whereas those of *R. miehei* and *R. pusillus*, although similar morphologically, may be better adapted to colonize animals. Temperature preference, however, seems to be a good character for distinguishing between *Mucor* and *Rhizomucor*. The higher growth temperature optimum has been also shown to be a character allowing segregation of a new family *Mycocladiaceae* from the mesophilic family *Absidiaceae* (Hoffmann et al.

2007). Interestingly, the thermotolerant *R. pusillus* and *R. miehei* appear closely related to *Mycocladiaceae*.

After careful phylogenetic studies based on ITS and SSU rDNA data, we propose to validate the name *M. luteus* that was in use before the reexamination of the *M. hiemalis* group (Schipper 1973, Schipper 1978a). This taxon was originally included in *M. hiemalis* solely on the basis of mating experiments. However, it is worth noting that not all strains of *M. hiemalis* f. *luteus* formed zygosporangia with other strains of *M. hiemalis* (Schipper 1973). Although it had been shown that fungi in *Mucor* can form sterile zygosporangia (Gauger 1965), those capacities were not examined in studies by Schipper (1973). Moreover, all mucoralean fungi (as well as *Mortierellaceae*) form zygosporangia through interaction of trisporic acid cycle products. This phenomenon could be interspecific (Schimek et al. 2003). Morphological and molecular data confirm the legitimacy of delimiting this taxon as a separate species. However, one should note that *M. mucedo*, type species of the genus, does not form a monophyletic clade with the *M. hiemalis* group. Therefore, species within the *M. hiemalis* group ultimately should be transferred from *Mucor* to a separate genus. However, additional phylogenetic studies within *Mucor* are required in order to elucidate the relationship of the type, *M. mucedo*, to the *M. hiemalis* clade.

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Literature cited

- Chen GQ, Zheng RY. 1986. A new species of *Mucor* with giant spores. *Acta Mycologica Sinica*. Supplement I, 1: 56–60.
- Costa AR, Porto E, Tayah M, Valente NY, Lacaz Cda S, Maranhão WM, Rodrigues MC. 1990. Subcutaneous mucormycosis caused by *Mucor hiemalis* Wehmer f. *luteus* (Linnemann) Schipper 1973. *Mycoses* 33(5): 241–246.
- Eddy S. 1998. Profile hidden Markov models. *Bioinformatics* 14: 755–763.
- Fresenius JBGW. 1850. *Beiträge zur Mykologie* 1: 1–38.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity of basidiomycetes: application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118.
- Gauger W. 1965. The germination of zygosporangia of *Mucor hiemalis*. *Mycologia* 57: 634–641.
- Hall TA. 1999. BioEdit: a user – friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series* 41: 95–98.
- Hofacker IL, Fontana W, Stadler PF, Bonhoeffer S, Tacker M, Schuster P. 1994. Fast folding and comparison of RNA secondary structures. *Monatshefte f. Chemie* 125: 167–188.
- Hoffmann K, Discher S, Voigt K. 2007. Revision of the genus *Absidia* (Mucorales, Zygomycetes) based on physiological, phylogenetic, and morphological characters; thermotolerant *Absidia* spp. form a coherent group *Mycocladiaceae* fam. nov. *Mycological Research* 111(10): 1169–1183.

- Hoog GS, Guarro J, Gene J, Figueras MJ. 2000. Atlas of clinical fungi, ed. 2. Centraalbureau voor Schimmelcultures, Utrecht: 95.
- Huelsenbeck JP, Ronquist F. 2001. MrBayes: Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754–755.
- Kauff F, Lutzoni F. 2002. Phylogeny of *Gyalectales* and *Ostropales* (*Ascomycota*, *Fungi*): among and within order relationships based on nuclear ribosomal RNA small and large subunits. *Molecular Phylogenetics and Evolution* 25: 138–156.
- Kirk PM, Cannon PF, Minter DW, Stalpers J. 2008. Ainsworth & Bisby's Dictionary of the Fungi. 10th edition. CAB International Europe–UK.
- Korniłowicz-Kowalska T, Wrzosek M, Ginalska G, Iglík H, Bancierz R. 2006. Identification and application of a new fungal strain *Bjerkandera adusta* R59 in decolorization of daunomycin wastes. *Enzyme and Microbial Technology* 38: 583–590.
- Kwaśna H. 1997. Antagonistic effect of fungi communities from Scots pine fine roots on *Heterobasidion annosum* (Fr.) Bref. and *Armillaria ostoyae* (Romagn.) Herink growth. *Phytopathologia polonica* 13: 133–146.
- Landis FC, Gargas A. 2007. Using ITS secondary structure to create species specific oligonucleotide probes for fungi. *Mycologia* 99(5): 681–692.
- Linnemann G. 1936. Beitrag zu einer Flora der Mucorineae Marburgs. *Flora* 130: 176–217.
- Lucet MM, Costantin. 1900. *Rhizomucor parasiticus*. *Revue Générale de la Botanique* 12: 81–99.
- Markham N R, Zuker M. 2005. DINAMelt web server for nucleic acid melting prediction. *Nucleic Acids Research* 33: W577–W581.
- McNeill J, Barrie FF, Burdet HM, Demoulin V, Hawksworth DL, Marhold K, Nicolson DH, Prado J, Silva PC, Skog JE, Wiersema J, Turland NJ. 2006. International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress, Vienna, Austria, July 2005. *Regnum Vegetabile* 146. 568 p.
- Mehrotra BR, Baijal U, Mehrotra BS. 1966 (“1965”). Species of *Mucor* from India – I. *Sydowia* 19: 238–243.
- Mehrotra BS, Mehrotra BM. 1978. Another azygosporic species of *Mucor* from India. *Sydowia* 31: 94–96.
- Mirza J H, Khan SM, Begum S, Shagufta S. 1979. *Mucorales of Pakistan*. University of Agriculture, Faisalabad, Pakistan: 183 p.
- Nilsson RH, Kristiansson E, Ryberg M, Hallenberg N, Larsson KH. 2008. Intraspecific ITS variability in the kingdom Fungi as expressed in the international sequence databases and its implications for molecular species identification. *Evolutionary Bioinformatics* (4): 193–201.
- O'Donnell K, Lutzoni FM, Ward TJ, Benny GL. 2001. Evolutionary relationships among mucoralean fungi (*Zygomycota*): evidence for family polyphyly on a large scale. *Mycologia* 93: 286–296.
- Pei K.Q. 2000. A new variety of *Mucor variosporus* and the validation of *M. luteus* Linnemann and *M. variosporus* Schipper. *Mycosystema* 19(1): 10–12.
- Posada D, Crandall KA. 1998. Modeltest: testing the model of DNA substitution. *Bioinformatics* 14: 817–818.
- Ridgway R. 1912. Color standards and color nomenclature. Eliborn Classics. Washington.
- Russell BS. 1974. *Mycology Guidebook*. University of Washington Press. Seattle: 703 p.
- Schimek C, Kleppe A, Saleem AR, Voigt K, Burmester A, Wöstemeyer J. 2003. Sexual reactions in *Mortierellales* are mediated by the trisporic acid system. *Mycological Research* 107 (6): 736–747.
- Schipper MAA. 1973. A study on variability in *Mucor hiemalis* and related species. *Studies in Mycology* 4: 1–40.

- Schipper MAA. 1978a. On certain species of *Mucor* with a key to all accepted species. *Studies in Mycology* 17: 1–52.
- Schipper MAA. 1978b. On the genera of *Rhizomucor* and *Parasitella*. *Studies in Mycology* 17: 53–77.
- Schipper MAA, Samson RA. 1994. Miscellaneous notes on *Mucoraceae*. *Mycotaxon* 50: 475–491.
- Selig C, Wolf M, Müller T, Dandekar T, Schultz J. 2008. The ITS2 Database II: homology modeling RNA structure for molecular systematics. *Nucleic Acids Research* 36: 377–380.
- Subrahmanyam A. 1983. Studies on thermomycology. *Mucor thermo-hyalospora* sp. nov. *Bibliotheca mycologica* 91: 421–423.
- Swofford DL. 2002. Phylogenetic analysis using parsimony (PAUP). Version 4. Sunderland, Massachusetts: Sinauer Associates.
- Szypuła W, Pietrosiuk A, Suchocki P, Olszowska O, Furmanowa M, Kazimierska O. 2005. Somatic embryogenesis and in vitro culture of *Huperzia selago* shoots as potential source of huperzine A. *Plant Science* 168: 1443–1452.
- Voigt K, Cigelnik E, O'Donnell K. 1999. Phylogeny and PCR identification of clinically important *Zygomycetes* based on nuclear ribosomal-DNA sequence data. *Journal of Clinical Microbiology* 37: 3957–3964.
- Wehmer C. 1903. Der *Mucor* der Hanfrötte, *M. hiemalis* nov. spec. *Annales Mycologici* 1: 37–41.
- Watanabe T. 1994. Two new species of homothallic *Mucor* in Japan. *Mycologia* 86: 691–695.
- Zalar P, Hennebert GL, Gunde-Cimerman N, Cimerman A. 1997. *Mucor troglophilus*, a new species from cave crickets. *Mycotaxon* 65: 507–516.
- Zheng RY, Chen GQ. 1991. A non-thermophylic *Rhizomucor* causing human primary cutaneous mucormycosis. *Mycosystema* 4: 45–57.
- Zheng RY, Chen GQ. 1993. Another non-thermophylic *Rhizomucor* causing human primary cutaneous mucormycosis. *Mycosystema* 6: 1–12.
- Zheng RY, Jiang H. 1995. *Rhizomucor endophyticus* sp. nov., an endophytic *Zygomycetes* from higher plants. *Mycotaxon* 56: 455–466.
- Zuker M, Stiegler P. 1981. Optimal computer folding of large RNA sequences using thermodynamics and auxiliary information. *Nucleic Acids Research* 9(1): 133–148.
- Zycha H, Siepmann R, Linnemann G. 1969. *Mucorales*: eine Beschreibung aller Gattungen und Arten dieser Pilzgruppe. J.Cramer, Lehre. 355 p.

Lignocellulolytic *Agaricomycetes* from the Brazilian Cerrado biome

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Abstract — A checklist of the *Agaricomycetes* from the Brazilian Cerrado region is provided. It presents data on the distribution of 95 species, 23 families and 11 orders (*Agaricales*, *Atheliales*, *Auriculariales*, *Boletales*, *Corticiales*, *Gloeophyllales*, *Hymenochaetales*, *Polyporales*, *Russulales*, *Sebacinales*, and *Thelephorales*). Twenty-eight taxa previously recorded from the studied region are excluded from the final list. The full checklist is available at www.mycotaxon.com/resources/weblists.html.

Key words — *Basidiomycetes*, diversity, macrofungi

Introduction

Agaricomycetes comprises almost 21,000 species spread in 17 orders of *Basidiomycota* (Kirk et al. 2008) and includes wood-decomposing, parasitic, and ectomycorrhizal fungi (Hibbett 2006).

The biome Cerrado is considered as one of the 25 biodiversity hotspots in the world (Myers et al. 2000), with around 55% of it estimated to be lost with deforestation, mostly for agricultural purposes (Machado et al. 2004). It presently covers around 2,000,000 km² through eight of the 26 Brazilian States plus the Federal District (Fig. 1); 70% of the Cerrado is covered by savannahs of different densities and the rest mostly by an herbaceous layer composed by grasses (Rodrigues 2005, Franco 2005). The rainy season is from October to April, with short dry periods in January and February; the annual precipitation varies from 1,200 to 2,000 mm, and the mean temperature is around 22°C (Braga-Júnior & Domingues 2008).

Several studies about fungi have been recently carried out in this biome (Inácio & Dianese 2006, Dornelo-Silva et al. 2007, Hernández-Gutiérrez & Dianese 2008, 2009, Jungbluth et al. 2008, Pereira-Carvalho et al. 2009), but few about *Agaricomycetes* (Baseia & Milanez 2001a,b, 2002a,b, 2003, Baseia 2005, Baseia et al. 2007).

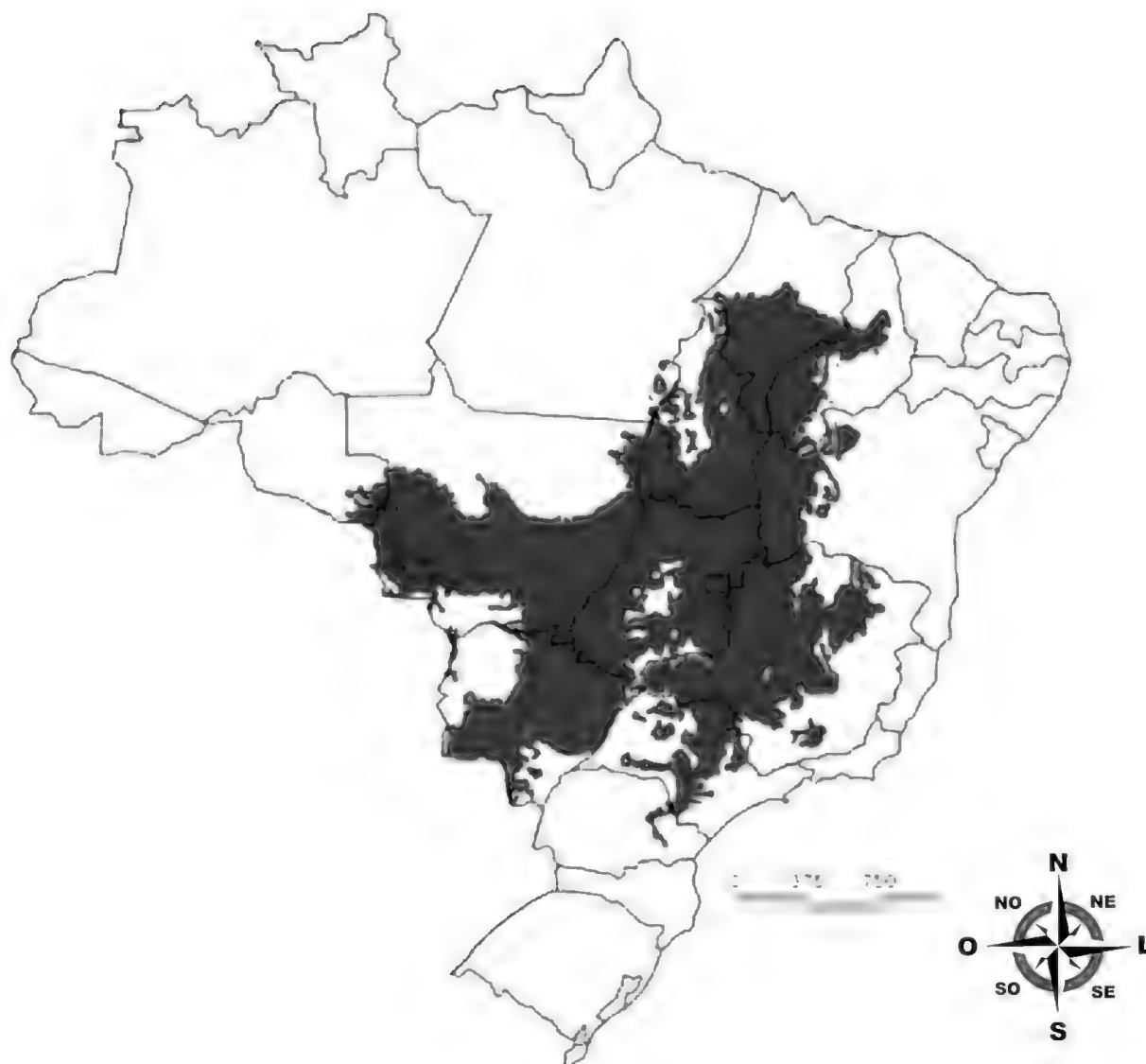


FIGURE 1. Cerrado biome in shadowed area (modified from: www.colegiosaofrancisco.com.br).

During the last Latin-American Mycology Congress (VI CLAM, 2008), a group of Latin-American researchers on the diversity of the aphyllophoraceous fungi was created and was committed to publish checklists of this fungal group for areas or countries in Latin America. Following this commitment, they are now providing new checklists (Baltazar & Gibertoni 2009, Drechsler-Santos et al. 2009, Gomes-Silva & Gibertoni 2009), and also contributing to the knowledge about the diversity of *Agaricomycetes* in endangered biomes in Brazil.

Material and methods

This study was based on bibliographic research (Sampaio 1916, with data of material collected in the State of Mato Grosso – unfortunately without indication of voucher specimens; Fidalgo et al. 1965, Bononi 1984, Gugliotta 1997, Baseia & Milanez 2001a,b, 2002a,b, 2003, Baseia 2005, Baseia et al. 2007, in the State of São Paulo). Nomenclature and classification systems follow those of Kirk et al. (2008), Index Fungorum (www.indexfungorum.org), Centraalbureau voor Schimmelcultures (www.cbs.knaw.nl), and CORTBASE (<http://andromeda.botinst.gu.se/cortbase.html>).

Results and discussion

The 95 species of *Agaricomycetes* reported from the Brazilian Cerrado represent 30 families and 12 orders (*Agaricales*, *Atheliales*, *Auriculariales*, *Boletales*, *Corticiales*, *Gloeophyllales*, *Hymenochaetales*, *Polyporales*, *Russulales*, *Sebacinales*, and *Thelephorales*). *Polyporales* is represented by 53 (57.7%) species and six families, followed by 23 (17.4%) species and 11 families of *Agaricales*. The higher diversity of *Polyporales* agrees with results of other basidiomycete inventories in different Brazilian regions and biomes (Baltazar & Gibertoni 2009, Drechsler-Santos et al. 2009, Gomes-Silva & Gibertoni 2009), which was expected for one of the largest groups in *Agaricomycetes*. In this study *Polyporaceae* Fr. ex Corda has the highest number of species (34, or 35.7% of the total), followed by *Hymenochaetaceae* Imazeki & Toki (14). Twenty-six species were excluded due to their temperate to boreal or restricted distribution or undefined nomenclature (Index Fungorum, Centraalbureau voor Schimmelcultures, and Cortbase), and their exsiccata should be revised. Up to now, the 95 species of this checklist represent our current knowledge about the diversity of *Agaricomycetes* in the Brazilian Cerrado biome. Further investigations, however, will certainly increase the number of fungal records and expand the reported species ranges throughout this endangered area.

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Literature cited

- Baltazar JM, Gibertoni TB. 2009. A checklist of the aphylloroid fungi (*Basidiomycota*) recorded from the Brazilian Atlantic rain forest. *Mycotaxon* 109: 439–442.
- Baseia IG. 2005. *Bovista* (*Lycoperdaceae*): dois novos registros para o Brasil. *Acta Botanica Brasilica* 19(4): 899–903.
- Baseia IG, Milanez AI. 2001a. *Crucivulum laeve* (Huds.) Kambly in cerrado vegetation of São Paulo State, Brazil. *Acta Botanica Brasilica* 15(1): 13–16.
- Baseia IG, Milanez AI. 2001b. *Nidularia pulvinata* (Schwein.) Fries (*Gasteromycetes*): a new record from Brazil. *Revista Brasileira de Botânica* 24(4): 479–481.
- Baseia IG, Milanez AI. 2002a. *Montagnea haussknechtii* Rab. (*Podaxales*) a rare agaricoid fungus: first record from Brazil. *Acta Botanica Brasilica* 16(3): 311–315.
- Baseia IG, Milanez AI. 2002b. *Tulostoma* (*Gasteromycetes*) from the cerrado region, State of São Paulo, Brazil. *Acta Botanica Brasilica* 16(1): 9–14.
- Baseia IG, Milanez AI. 2003. *Cyathus* (*Gasteromycetes*) in areas of the Brazilian cerrado region, São Paulo State. *Mycotaxon* 80: 493–502.
- Baseia IG, Silva BDB, Leite AG, Maia LC. 2007. O gênero *Calostoma* (*Boletales*, *Agaricomycetidae*) em áreas de Cerrado e semi-árido no Brasil. *Acta Botanica Brasilica* 21(2): 277–280.

- Bononi VLR. 1984. Basidiomicetos do Cerrado da Reserva Biológica de Moji-Guaçu, SP. *Rickia* 11: 1–25.
- Braga-Júnior BPF, Domingues AF. 2008. Gestão de Recursos Hídricos no Brasil. In: Faleiro FG, Farias-Neto AL (eds), *Savanas: desafios e estratégias para o equilíbrio entre sociedade, agronegócio e recursos naturais*. Embrapa Cerrados. Pp. 381–413.
- Dornelo-Silva D, Pereira-Carvalho RC, Dianese JC. 2007. New *Stenella* and *Parastenella* species from the Brazilian Cerrado. *Mycologia* 99: 753–764.
- Drechsler-Santos ER, Gibertoni TB, Góes-Neto A., Cavalcanti MAQ. 2009. A re-evaluation of the lignocellulolytic *Agaricomycetes* from the Brazilian semi-arid region. *Mycotaxon* 108: 241–244 (see also <http://mycotaxon.com/resources/weblists.html>).
- Fidalgo O, Fidalgo MEPK, Furtado JS. 1965. Fungi of the “Cerrado” region of São Paulo. *Rickia* 2: 55–71.
- Franco AC. 2005. Biodiversidade de forma e função: implicações ecofisiológicas das estratégias de utilização de água e luz em plantas lenhosas do Cerrado. In: Scariot A, Sousa-Silva JC, Felfili JM (orgs). *Cerrado: Ecologia, Biodiversidade e Conservação*. Pp. 179–196.
- Gomes-Silva AC, Gibertoni TB. 2009. Checklist of the aphyllorhaceous fungi (*Agaricomycetes*) of the Brazilian Amazonia. *Mycotaxon* 108: 319–322 (see also <http://mycotaxon.com/resources/weblists.html>).
- Gugliotta AM. 1997. Polyporaceae de Mata Ciliar da Estação Experimental e Reserva Biológica de Moji-Guaçu, SP, Brasil. *Hoehnea* 24(2): 89–106.
- Hernández-Gutiérrez A, Dianese JC. 2008. New cercosporoid fungi from the Brazilian Cerrado 1. Species on hosts of the families *Anacardiaceae*. *Mycotaxon* 106: 41–63.
- Hernández-Gutiérrez A, Dianese JC. 2009. New cercosporoid fungi from the Brazilian Cerrado 2. Species on hosts of the subfamilies *Caesalpinioideae*, *Faboideae* and *Mimosoideae* (*Leguminosae* s. lat.). *Mycotaxon* 107: 1–24.
- Hibbett DS. 2006. A phylogenetic overview of the *Agaricomycotina*. *Mycologia* 98(6): 917–925.
- Inácio CA, Dianese JC. 2006. Follicolous fungi on *Tabeluia* species from the Cerrado. *Mycological Progress* 5(2): 120–127.
- Jungbluth P, Marcelli MP, Elix JA. 2008. Five new species of *Bulbothrix* (*Parmeliaceae*) from cerrado vegetation in São Paulo State, Brazil. *Mycotaxon* 104: 51–63.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. *Ainsworth & Bisby's dictionary of the Fungi*. 10^o Ed, CAB International.
- Machado RB, Ramos-Neto MB, Pereira PGP, Caldas EF, Gonçalves DA, Santos NS, Tabor K, Steininger M. 2004. Estimativas de perda da área do Cerrado brasileiro. Technical report not published. *Conservação Internacional* (in: <http://www.conservation.org.br/arquivos/RelatDesmatamCerrado.pdf>).
- Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.
- Pereira-Carvalho RC, Sepúlveda-Chavera G, Armando EAS, Dianese JC. 2009. An overlooked source of fungal diversity: novel hyphomycete genera on trichomes of cerrado plants. *Mycological Research* 113: 261–274.
- Rodrigues MT. 2005. A biodiversidade dos cerrados: conhecimento atual e perspectivas, com uma hipótese sobre o papel das matas galerias na troca faunística durante ciclos climáticos. In: Scariot A, Sousa-Silva JC, Felfili JM (orgs). *Cerrado: Ecologia, Biodiversidade e Conservação*. Pp. 235–246.
- Sampaio AJ. 1916. A flora de Matto Grosso. *Arquivos do Museu Nacional* 19: 1–127.

Myxomycete diversity of the Altay Mountains (southwestern Siberia, Russia)

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Abstract — A survey of 1488 records of myxomycetes found within a mountain taiga-dry steppe vegetation gradient has identified 161 species and 41 genera from the southeastern Altay mountains and adjacent territories of the high Ob' river basin. Of these, 130 species were seen or collected in the field and 59 species were recorded from moist chamber cultures. Data analysis based on the species accumulation curve estimates that 75–83% of the total species richness has been recorded, among which 118 species are classified as rare (frequency < 0.5%) and 7 species as abundant (> 3% of all records). Among the 120 first species records for the Altay Mts. are 6 new records for Russia. The southeastern Altay taiga community assemblages appear highly similar to other taiga regions in Siberia but differ considerably from those documented from arid regions. The complete and comprehensive illustrated report is available at <http://www.Mycotaxon.com/resources/weblists.html>.

Key words — biodiversity, ecology, slime moulds

Introduction

The myxomycete diversity of coniferous boreal forests of Siberia is poorly studied. So far, only a few local species inventories are available (Novozhilov et al. 1999, Kosheleva et al. 2008). Prior to this study, only 41 species had been recorded from the Altay Mts. in Russia (Barsukova 2000, Lavrov 1929, Novozhilov 1987). During four weeks in August 2008, the central and southeastern Altay Mts. and lowland forests near Barnaul city were studied by the first three authors conducted extensive fieldwork as well as substrate collecting for moist chamber cultures. Objectives of this study were: (1) to obtain baseline data on myxomycete abundance and biodiversity in the Russian Altay, (2) to determine to what extent myxomycete assemblages follow the vegetation and precipitation

gradients in the region, and (3) to use abundance data to estimate the degree of completeness that can be achieved in a quantitative survey.

Materials and methods

Our study regions are situated in north, central, and southeastern Altay: near Barnaul city; around Lake Teletskoe (the Altay State Nature reserve); and numerous localities along state road M32 (Chuyskiy Trakt), which essentially follows the northwest–southeast rainfall gradient over several ridges of the Altay Mts. towards the Russian–Mongolian border.

Localities were assigned to one of six vegetation types (Kamelin et al. 2005): steppe (8 localities), mountain forest–steppe (14 localities), light coniferous taiga (10 localities), stripe pine forest (11 localities), dark coniferous taiga (30 localities), and “chernevaya” taiga (27 localities).

A total of 510 substrate samples were collected for moist chamber cultures. These included bark from living trees and shrubs, plant leaf litter, litter of grasses and herbaceous plants, decaying conifer cones on the ground, litter of small twigs, woody debris, and the dung of herbivorous animals such as camel, cow, horse, sheep, and various rodents. Moist chamber cultures were prepared according to Härkönen (1977). A species accumulation curve was used (Colwell 2006) to estimate the extent to which our survey was exhaustive. Species diversity was calculated using Shannon’s diversity index H' . The myxomycete assemblages were compared by using the adjusted incidence-based Sørensen index developed by Chao et al. (2006) and computed with EstimateS. Voucher specimens have been deposited in their respective institutes by Novozhilov [Fungal Herbarium, Komarov Botanical Institute, Laboratory of Systematics and Geography of Fungi (LE)], Schnittler [Botanische Staatssammlung München (M)], and Fefelov [Institute of Plant and Animal Ecology of the Russian Academy of Sciences].

The annotated checklist of the region was compiled from the results of our quantitative survey, the collections of the fourth author and published studies. Since the three publications available for the region give rough annotations of abundance as well, we could assign an abundance estimate according to Stephenson et al. (1993) to all taxa.

Results and discussion

SPECIES DIVERSITY — This study was based on a total of 1488 records representing 161 taxa from 41 genera and 11 families. However, 118 taxa were classified as rare for whole study area ($< 0.5\%$ of all records). We report 120 taxa for the first time for the Altay Mts. of which 6 are new records for Russia. The quantitative part of the survey considers 1174 records representing 152 species. Of these, a total of 315 records were derived from 510 moist chamber cultures, which served to complement the field component. Approximately 40% of the species determined to be common (19 of 45) were observed in the field as well as in moist chamber cultures. In contrast, most lignicolous species and those found to inhabit the forest floor litter were only found in the field (102 species, 805 records in total). Almost all records of (59 of 81) from dry steppe and forest-steppes originate from moist chamber cultures.



MAP OF THE ALTAY MOUNTAIN REGION. Sampled localities are indicated by black rectangles. Lakes, rivers and lowland forests are marked dark gray. A dotted black line indicates the borders between countries, and between Russian administrative political territories.

INSET: geographical position of the study area. Sources: Microsoft Encarta Reference Library, 2002 and Google Earth (modified).

DISTRIBUTION PATTERNS OF MYXOMYCETES WITHIN VEGETATION TYPES OF THE ALTAY MTS. — Collectively the species observed in the field and those recovered from moist chamber cultures, displayed a pronounced trend of increasing alpha-diversity and species richness moving from dry steppe to dark coniferous taiga and secondary mixed aspen and birch forests and to “chernevaya” taiga and mixed forests and then decreased again moving to stripe pine and mixed forests in submontane landscape in the forest-steppe zone. In addition, the species/genus (S/G) ratio was rather low in the dry steppe vegetation. Myxomycete assemblages from arid regions of the Altay Mts. showed high similarities with those of other Central Asian regions. The myxomycete assemblages of the light coniferous taiga and stripe pine forest can be regarded as depauperate versions of the dark coniferous forests.

SUBSTRATE-SPECIES RELATIONSHIPS — Both species richness and diversity varied considerably within groups of substrates, with wood housing the most diverse myxomycete community. However, in spite of a high number of samples processed, wood performed poor in moist chambers when compared to field collections. An unexpected result of this study was the discovery quite rich myxomycete assemblage on decaying conifer cones. This substrate is slightly acidic, and all species were recorded from moist chambers. Most common was *Echinostelium minutum* and *E. corynophorum*.

Conclusions

There seem to be numerous explanations for the relatively high diversity of myxomycetes in the Altay Mountains (a region with ca. 2700 vascular plants, Kamelin 2005), where 161 species of myxomycetes are now known, compared with other regions. First, the rainfall gradient and the diverse vegetation types

associated with it allow desert myxomycetes (e.g. *Physarum* cf. *notabile*) as well as species adapted to moss-covered wood (e.g. *Barbeyella minutissima* and *Colloderma oculatum*) to exist. Second, the continental climate results in fairly high summer temperatures, allowing some species with mainly tropical distributions (*Cribraria languescens*, *Physarum globuliferum*, and *Tubulifera microsperma*) to persist. In general, pronounced fluctuations (both in temperature and rainfall) seem to favor myxomycetes with their various dormant stages over the true fungi, supporting the hypothesis of a reverse pattern of global diversity in myxomycetes, with deserts and temperate forests being more diverse than moist tropical forests. Detailed analysis of myxomycete diversity and ecology in the study area are presented on the web paper.

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Literature cited

- Barsukova TN. 2000. Myxomycetes from the Lake Teletskoe vicinity, the Altay State Nature reserve. *Mikologia i Fitopatologia* 34: 6–9 [in Russian].
- Chao A, Li PC, Agatha S, Foissner W. 2006. A statistical approach to estimate soil ciliate diversity and distribution based on data from five continents. *Oikos* 114: 479–493.
- Colwell RK. 2006. EstimateS: Statistical estimation of species richness and shared species from samples. Version 8.0. User's Guide and application. <<http://purl.oclc.org/estimates>> (accessed 10 June 2009).
- Härkönen M. 1977. Corticolous myxomycetes in three different habitats in southern Finland. *Karstenia* 17: 19–32.
- Kamelin RV, Kutzev MG, Shaulo DN, Shmakov AI, Tikhonov DV, Viane RLL. 2005. *Flora Altaica*. Vol. I. *Lycopodiophyta*, *Equisetophyta*, *Polypodiophyta*. Azbuka: Barnaul (Russia). 340 pp.
- Kosheleva AP, Novozhilov YK, Schnittler M. 2008. Myxomycete diversity of the State reserve “Stolby” (southeastern Siberia, Russia): a preliminary report. *Fung. Div.* 31: 45–62.
- Lavrov NN. 1929. *Formae novae myxomycetum Sibiriae*. *Sistematicheskie zametki po materialam gerbaria Tomskovo Universiteta*. 4–5: 1–3 [in Latin].
- Novozhilov YK. 1987. Myxomycetes of the Altay State Nature reserve. *Novosti Sistematiki Nizshikh Rasteniy* 24: 113–116. [in Russian].
- Novozhilov YK, Schnittler M, Stephenson SL. 1999. Myxomycetes of the Taimyr Peninsula (north-central Siberia). *Karstenia* 39: 77–97.
- Stephenson SL, Kalyanasundaram I, Lakhanpal TN. 1993. A comparative biogeographical study of myxomycetes in the mid-Appalachians of eastern North America and two regions of India. *Journal of Biogeography* 20: 645–657.

A new species of *Hydropisphaera*, *H. bambusicola*, is the sexual state of *Gliomastix fusigera*

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Abstract — *Hydropisphaera bambusicola* sp. nov. (*Bionectriaceae*, *Hypocreales*) is described and illustrated based on a collection from *Bambusa vulgaris* in Martinique. The asexual state was obtained in culture and identified as *Gliomastix fusigera*. *Gliomastix fusigera* is an anamorphic species that occurs on members of the *Arecaceae* and *Poaceae* throughout the tropics and for which no sexual state is known. *Hydropisphaera bambusicola* is distinctive in having aseptate, striate ascospores. All other species of *Hydropisphaera* and most species of the *Bionectriaceae* have one or more septate ascospores. *Hydropisphaera bambusicola* and eight other species in *Hydropisphaera* are unusual in having fasciculate hairs near the perithecial apex. A key to the species of *Hydropisphaera* with hairs is presented.

Key words — *Acremonium*, *Ascomycota*, bamboo, *Ijuhya*, *Protocreopsis*

Introduction

The genus *Hydropisphaera* Dumort., based on the type species *H. peziza* (Tode) Dumort., was established by Dumortier (1822), but was long considered to be a synonym of the genus *Nectria* (Fr.) Fr. Rossman et al. (1999) resurrected *Hydropisphaera* as a distinct genus in the *Bionectriaceae* (*Hypocreales*) for species of *Nectria*-like fungi that had previously been placed in the *N. peziza* group (Booth 1959, Samuels 1976, Rossman 1983). The ascomata of *Hydropisphaera* are yellow, orange to brown, and do not change color in potassium hydroxide or lactic acid, which is characteristic of the *Bionectriaceae*. *Hydropisphaera* is distinguished from other genera in the *Bionectriaceae* by the relatively wide ascomatal wall, greater than 25 µm wide, composed of thin-walled cells that often collapse upon drying to form cupulate perithecia. Rossman et al. (1999) recognized 18 species in *Hydropisphaera* and five additional species have been

added since then. Where known, the asexual states of species of *Hydropisphaera* are considered to be *Acremonium*-like.

During the course of a research program on the fungal diversity of the Lesser Antilles, an interesting specimen of the genus *Hydropisphaera* was discovered in Martinique and it was determined to represent a previously undescribed species. This specimen was cultured from single ascospores that produced an asexual state that was identified as *Gliomastix fusigera*. This new species and its asexual state are described and illustrated below. DNA sequence data from the ITS region and the nLSU rRNA gene have been deposited in GenBank.

Materials & methods

Specimens were examined using the methods described by Rossman et al. (1999). Microscopic observations and measurements were made in water, and ascospore ornamentation was observed in lactic cotton blue. In the descriptions, an ^m indicates average or mean, and n is the number of structures that were measured. Sequence data from the ITS region and the nLSU rRNA gene were obtained via the methods of Samuels et al. (2009) and submitted to GenBank.

Taxonomy

Hydropisphaera bambusicola Lechat, sp. nov.

FIGS. 1–2

MYCOBANK MB 515218; GENBANK GU059594 (ITS) & GU059595 (nLSU rRNA)

Ascomata subglobosa, apice applanata, 220–260 µm alta, diametro 300–360 µm diametro, aurantius vel rubro bruneus, corona subapicalis pilis agglutinatis aurantia, crasse-tunicatis, flexuosis composita, colore in KOH vel acido lactico non mutanda. Asci 90–96 × 12–16 µm, octospori, unitunicati, inamyloidei. Ascosporae fusiformes, (18.5–)20–24.8(–28.2) × (4.8–)5.2–7(–8.2) µm, hyalinae, aseptatae, striatae.

HOLOTYPE: French West Indies. Martinique. Prêcheur, Anse Couleuvre, sentier de la cascade Couleuvre, in culmis emortuis *Bambusa vulgaris*, 25.VIII.2008, leg. Christian Lechat CLL8323 (LIP), ex-typus in CBS 124147.

ETYMOLOGY: The epithet is derived from the host genus of the substrate.

PERITHECIA solitary or crowded in groups of 2–10, superficial, subglobose, (200–)220–260(–300) µm high × (250–)300–360 µm diam. (^m = 250 × 325 µm, n = 20), reddish-brown, collapsing cupulate when dry, not changing color in 3% KOH or lactic acid. **PERITHECIAL APEX** with short, acute papilla, margin with fasciculate, thick-walled hairs, arising from cells of ascomatal wall, hairs agglutinated to form triangular teeth, hairs arranged in a stellate fringe around upper margin of perithecia. **HAIRS** 80–100 µm long, 2.5–3 µm wide, brownish-orange, cylindrical, slightly flexuous, thick-walled (0.8–1.5 µm), rounded at tips, septate. **PERITHECIAL WALL** 50–70 µm thick, composed of two regions: outer region 30–50 µm wide, of globose to ellipsoidal 15–20 × 12–15 µm cells,

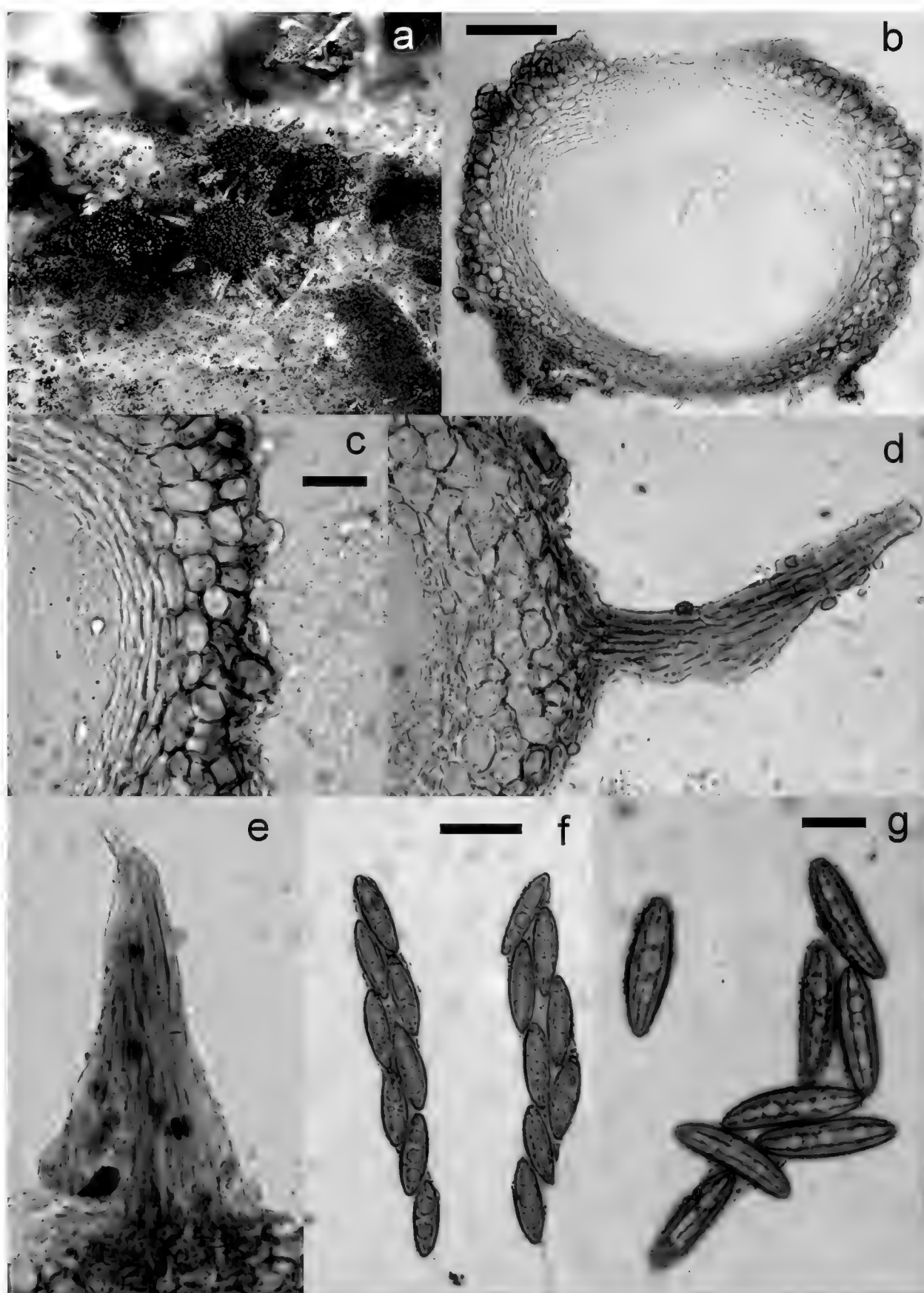


FIG. 1. *Hydropisphaera bambusicola* (based on holotype material). a. Perithecia. b. Median section of perithecium. c. Median section of perithecial wall. d–e. Fasciculate hairs. f. Asci. g. Ascospores.

Scale bars = 50 μm for b, 20 μm for c–f; use bar in c for c–e, 10 μm for g. Note: ascospores were stained with lactic cotton blue. Additional photos at <http://www.ascofrance.fr>.

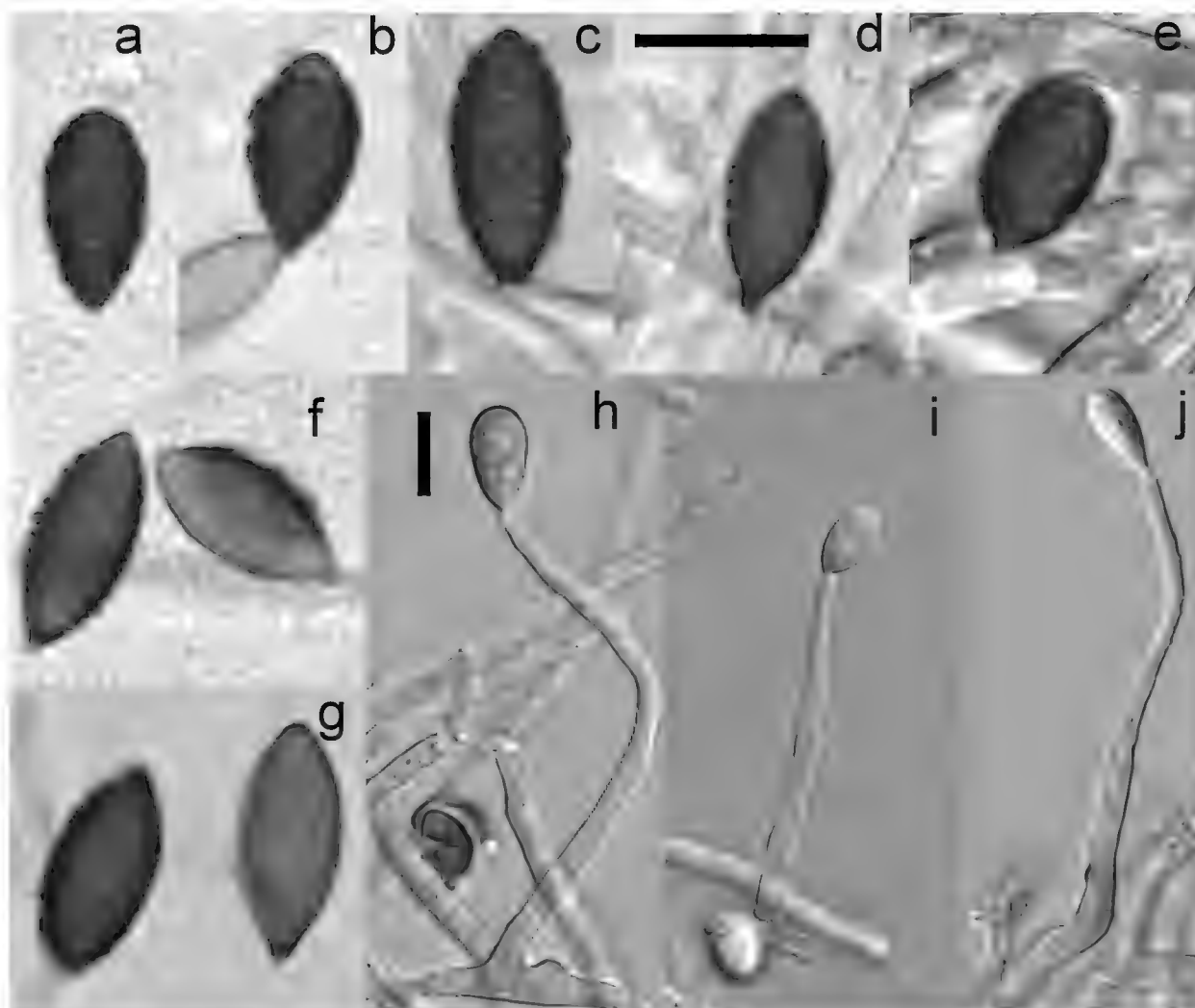


FIG. 2. *Gliomastix fusigera* (based on culture obtained from single ascospore isolate of holotype of *Hydropisphaera bambusicola*). a–g. Conidia. h–j. Conidiophores and conidiogenous cells.

Scale bars = 10 μ m for all; use bar in d for a–g and bar in h for h–j.

with yellow to orange walls 1–1.5 μ m thick; inner region 15–20 μ m wide, of elongate, flattened cells 10–15 \times 5–7 μ m, with hyaline walls 1.5–2 μ m thick. BASAL HYPHAE hyaline to yellowish, 3–3.5 μ m diam., flexuous, smooth. ASCI (85–)90–96(–100) \times (10–)12–16(–17) μ m (\bar{m} = 94.5 \times 14 μ m, n=20), clavate, apices rounded, without ring, with 8 biseriate ascospores. ASCOSPORES (18.5–)20–24.8(–28.2) \times (4.8–)5.2–7(–8.2) μ m (\bar{m} = 23.6 \times 6.7 μ m, n=30), fusiform, aseptate, hyaline, striate with striations finely verrucose.

Anamorph

Gliomastix fusigera (Berk. & Broome) C.H. Dickinson, Mycol. Pap. 115: 7. 1968.

≡ *Monotospora fusigera* Berk. & Broome, J. Linn. Soc., Bot. 14: 99. 1873.

≡ *Acremonium fusigerum* (Berk. & Broome) W. Gams, *Cephalosporium-artige Schimmelpilze (Hyphomycetes)*: 94. 1971.

IN CULTURE: COLONY after one week on PDA, 11–12 mm diam., regularly cottony-fluffy hyphae, olivaceous grey, white at margin, reverse olivaceous grey, lacking sporulation; after two weeks, 24 mm diam., cottony-fluffy hyphae

with greater height towards the middle, otherwise appearing similar, but with light sporulation; after one week on CMA, 18 mm diam., thin sparse aerial hyphae, hyaline, sporulating, reverse hyaline; after two weeks, 36 mm diam., appearance same as one week.

MYCELIUM with hyphae branching, septate, hyaline to pale brown, smooth, width 3–5 μm . CONIDIOPHORES borne on aerial hyphae, macronematous, mononematous, unbranched, elongate, erect, straight to flexuous, hyaline to light brown, surface smooth to very faintly roughened. CONIDIOGENOUS CELLS integrated, monophialidic, terminal, subulate towards apex, at times with a minutely flared collarete, length 31–60 μm with width at apex 1.5–2 μm and at base 3–4.5 μm . CONIDIA solitary or catenulate in short chains, obpyriform to fusiform with apices rounded to somewhat acute and bases having a prominent, almost apiculate hilum, aseptate, walls smooth to verrucose, hyaline becoming dark brown with ends at times paler and dark brown to black in mass, $6.3\text{--}17.2 \times 5.0\text{--}8.5 \mu\text{m}$ ($m = 13.2 \times 6.6 \mu\text{m}$, $n = 73$).

ADDITIONAL SPECIMEN EXAMINED: USA. FLORIDA: Miami-Dade Co. NORTH MIAMI, ENCHANTED FOREST ELAINE PARK, on rachis of dead *Sabal palmetto* leaf, 30.VI.2007, leg. Gregorio Delgado. (BPI 878844).

The above description includes data from the anamorphic culture obtained from the single ascospore isolate of the holotype of *Hydropisphaera bambusicola*.

Discussion

Hydropisphaera bambusicola is placed in the genus *Hydropisphaera* based on the brownish-orange, KOH–, lactic acid– ascomatal wall of large, thin-walled cells that result in cupulate perithecia upon drying. This species appears similar to species of *Ijuhya* Starbäck, many of which have fasciculate hairs around the perithecial apex, striate ascospores, and occur on monocotyledonous plants. However, *H. bambusicola* differs from species of *Ijuhya* in that the latter have an ascomatal wall composed of cells with a thickened wall and the perithecia generally do not become cupulate upon drying. The ascospores of *H. bambusicola* resemble those of *Protocreopsis* Yoshim. Doi in being coarsely striate with striae that are somewhat wavy. In addition, most species of *Protocreopsis* occur on monocotyledonous plants. However, *Hydropisphaera bambusicola* is unlike species of *Protocreopsis* in that it lacks white to tan hyphae that envelop the ascomatal wall.

Within the genus *Hydropisphaera*, a number of known species have an apical crown of long, fasciculate hairs, and a key to such species is presented below. *Hydropisphaera bambusicola* differs from all species of *Hydropisphaera* in having non-septate ascospores. The known asexual state for species of *Hydropisphaera* is considered *Acremonium*-like with hyaline, non-septate conidia borne on unbranched conidiophores similar to those known for species of *Ijuhya*. None

of these species have an asexual state resembling the characteristic *Gliomastix* asexual state of *H. bambusicola*.

The anamorph of *H. bambusicola* belongs to the genus *Gliomastix* Guég. as *G. fusigera*, which was redescribed by Dickinson (1968). This anamorph has been reported on monocotyledonous hosts, specifically species in the *Arecaceae* and *Poaceae* in tropical regions. Although primarily known from the Old World, especially in Asia (Matsushima 1975, Zhuang 2001), several reports including a recent mention of this species on *Sabal palmetto* in Florida, USA (Delgado 2009) suggest that *G. fusigera* is pantropical. *Gliomastix fusigera* is one of the two species of *Gliomastix* having conidia that are typically much longer than 12 µm. The other species, *G. elata* C.H. Dickinson, has narrowly fusiform conidia and is known from *Musa* in Sierra Leone (Dickinson 1968, Ellis 1971). Since the anamorph of *Wallrothiella subiculosa* Höhn. was transferred to *Pseudogliomastix* W. Gams (Gams & Boekhout 1985), no other sexual state is known for any species of *Gliomastix*. Gams (1971) regarded *Gliomastix* as a synonym of *Acremonium* Link and classified all species in that genus as *Acremonium* section *Gliomastix* (Guég.) W. Gams. This study confirms the prediction that these fungi would be connected to a sphaeriaceous teleomorph (Gams 1978). However, based on the dark brown conidia that contrast with the hyaline conidia of true *Acremonium*, many authors have regarded *Gliomastix* as a distinct genus (Dickinson 1968, Ellis 1971, Hammill 1981, Delgado 2009). The type of *Gliomastix* is *Gliomastix chartarum* (Corda) S. Hughes, a species which is now correctly given the name of the taxonomic synonym, *Gliomastix murorum* (Corda) S. Hughes (= *Acremonium murorum* (Corda) W. Gams). DNA sequence similarity and our preliminary, unpublished phylogenetic analyses suggest *Hydropisphaera bambusicola* with its *G. fusigera* anamorph is closely related to the type of *Gliomastix* as well as species of *Hydropisphaera*. Schoch et al. (2009) also showed a close relationship between *Gliomastix* and *Hydropisphaera*. Since the type of *Acremonium*, *Acremonium alternatum* Link, appears to belong to a different clade of the *Bionectriaceae* and that for some time *Acremonium* has been thought of as polyphyletic, we feel that the use of *Gliomastix* as a form genus distinct from *Acremonium* is warranted.

Key to species of *Hydropisphaera* with fasciculate hairs

(Modified from Rossman et al. 1999)

- 1. Ascospores averaging more than 25 µm long 2
- 1. Ascospores averaging less than 25 µm long 4
- 2. Ascomata dark red with red hairs; ascospores spinulose-striate
..... *H. haematites* (Syd. & P. Syd.) Rossman & Samuels
- 2. Ascomata dark orange to brown with concolorous hairs;
ascospores smooth-walled 3

3. Ascospores $48\text{--}55 \times 6\text{--}7 \mu\text{m}$; ascomata dark orange with orange hairs
..... *H. gigantea* (Speg.) Rossman & Samuels
3. Ascospores $25\text{--}38 \times 5\text{--}7 \mu\text{m}$; ascomata brown with brown hairs
..... *H. dolichospora* (Penz. & Sacc.) Rossman & Samuels
4. Ascomata with white to orange, fasciculate hairs; ascospores averaging
more than $17 \mu\text{m}$ long 5
4. Ascomata with white, fasciculate hairs; ascospores averaging
less than $17 \mu\text{m}$ long. 7
5. Ascospores aseptate *H. bambusicola*
5. Ascospores one-septate 6
6. Ascomata orange with orange hairs; ascospores $17\text{--}23 \times 5\text{--}7 \mu\text{m}$,
striate *H. cyatheae* (Dingley) Rossman & Samuels
6. Ascomata yellow to nearly brown with white hairs; ascospores $16\text{--}22 \times 4\text{--}5 \mu\text{m}$,
striate or spinulose *H. leucotricha* (Penz. & Sacc.) Rossman & Samuels
7. Ascospores striate; ascomata pale yellow to yellow
..... *H. suffulta* (Berk. & M.A. Curtis) Rossman & Samuels
7. Ascospores smooth or spinulose, not striate; ascomata orange to dark orange 8
8. Ascospores $12.5\text{--}17.5 \times 3.5\text{--}4 \mu\text{m}$, spinulose
..... *H. rufofusca* (Penz. & Sacc.) Rossman & Samuels
8. Ascospores $12\text{--}15 \times 4\text{--}5 \mu\text{m}$, smooth
..... *H. boothii* (D. Hawksw.) Rossman & Samuels

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Literature cited

- Booth C. 1959. Studies in pyrenomycetes: IV. *Nectria* (part 1). Mycol. Pap. 73: 1–115.
- Delgado G. 2009. South Florida microfungi: *Veramycella bispora*, a new palmicolous anamorphic genus and species, with some new records for the continental USA. Mycotaxon 107: 357–373.
- Dickinson CH. 1968. *Gliomastix* Guéguen. Mycol. Pap. 115: 1–24.
- Dumortier BCJ. 1822. Commentationes Botanicae. C. Casterman-Dieu, Tournay, Belgium.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England.

- Gams W. 1971. *Cephalosporium*-artige Schimmelpilze (*Hyphomycetes*). Gustav Fischer Verlag, Stuttgart, Germany.
- Gams W. 1978. Connected and disconnected chains of phialoconidia and *Sagenomella* gen. nov. segregated from *Acremonium*. *Persoonia* 10: 97–112.
- Gams W, Boekhout T. 1985. Pigment localization in dematiaceous hyphomycetes and the segregation of *Pseudogliomastix* gen. nov. from *Acremonium*. *Proc. Indian Acad. Sci., Pl. Sci.* 94: 273–280.
- Hammill TM. 1981. On *Gliomastix murorum* and *G. felina*. *Mycologia* 73: 229–237.
- Matsushima T. 1975. *Icones Microfungorum a Matsushima Lectorum*. Nippon Printing & Publishing Co., Ltd., Osaka, Japan.
- Rossmann AY. 1983. The phragmosporous species of *Nectria* and related genera (*Calonectria*, *Ophionectria*, *Paranectria*, *Scoleconectria* and *Trichonectria*). *Mycol. Pap.* 150: 1–164.
- Rossmann AY, Samuels GJ, Rogerson CT, Lowen R. 1999. Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* 42: 1–248.
- Samuels GJ. 1976. Perfect states of *Acremonium*. The genera *Nectria*, *Actiniopsis*, *Ijuhya*, *Neohenningsia*, *Ophiodictyon*, and *Peristomialis*. *New Zealand J. Bot.* 14: 231–260.
- Samuels GJ, Lu B-S, Chaverri P, Candoussau F, Fournier J, Rossmann AY. 2009. *Cyanonectria*, a new genus for *Nectria cyanostoma* and its *Fusarium* anamorph. *Mycol. Progr.* 8: 49–58.
- Schoch CL et al. 2009. The *Ascomycota* tree of life: A phylum-wide phylogeny clarifies the origin and evolution of fundamental reproductive and ecological traits. *Systematic Biology* 58: 224–239.
- Zhuang W-Y. 2001. *Higher Fungi of Tropical China*. Mycotaxon, Ltd., Ithaca, NY.

The first record of *Neurospora tetrasperma* (anam. *Chrysonilia tetrasperma*) on *Platanus orientalis* in Iran

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Abstract — Sexual reproduction by *Neurospora tetrasperma* is reported and illustrated from Iran on *Platanus orientalis* in nature, the first report from Iran. It was found on a new host for this fungus.

Key words — teleomorph, morphology, taxonomy, fungi

Introduction

Shear & Dodge (1927) introduced the generic name *Neurospora* for four species characterized by dark ascospores with a grooved surface and longitudinal ribs. Numerous species were later added to the genus by others (Tai 1935, Gochenaur & Backus 1962, Nelson et al. 1964, Frederick et al. 1969, Mahoney et al. 1969, von Arx 1981, Perkins & Raju 1986, Krug & Khan 1991). Heterothallic/pseudohomothallic *Neurospora* species have been distinguished in the past by the morphological and biological species concepts (Turner et al. 2001, Dettman et al. 2003a, b). When *N. crassa*, *N. sitophila*, *N. intermedia* and *N. tetrasperma* were described in 1927 and 1935, intra- and interspecific crosses showed clear differences that influenced the authors of the descriptions (Shear & Dodge 1927, Tai 1935) well before the biological species concept was published in 1942 (Mayr 1942). Although morphology was the basis of the descriptions of the four species cited above, reproductive isolation measured by mating success has been regarded as a more reliable method for the identification of heterothallic

Neurospora (Perkins & Raju 1986, Perkins & Turner 1988, Shear & Dodge 1927, Tai 1935). Morphology nonetheless continues to be useful for identifying *N. tetrasperma* because this pseudohomothallic species produces perithecia with asci containing four dikaryotic and binucleate spores, as opposed to the eight-spored asci found in all other *Neurospora* species (Turner et al. 2001).

Morphological species recognition (MSR) is the dominant method of species recognition because it is an integral element of the description of every species and can be applied to most eukaryotic organisms (Dettman et al. 2003b). If sexual reproduction can be assessed, biological species recognition (BSR) using mating tests may be used to designate reproductively isolated biological species sensu Mayr (1942). However, the relationship between mating behavior in the laboratory and the potential to interbreed in nature often is unclear, and sexual activity has not been observed in nature or the laboratory for approximately 20% of the fungal kingdom (Hawksworth et al. 1995). Phylogenetic species recognition (PSR) accepts additional genetically isolated species that had not been recognized previously due to the lack of taxonomically informative morphological characters (phenotypic simplicity or plasticity) or incomplete reproductive isolation among species (Taylor et al. 2000). Typically, a single morphological or biological species with a cosmopolitan distribution is found to be composed of multiple cryptic, phylogenetic species that often are geographically distinct. In addition, PSR is applicable to all organisms, including those that cannot be induced to mate in the laboratory, as is required for BSR. For these reasons, PSR is becoming more popular for differentiating species, especially among mycologists, and is challenging BSR as the method of choice (Taylor et al. 2000).

Recently PSR of outbreeding *Neurospora* individuals has identified at least 15 genetically isolated, species-level clades, where previous BSR using mating to tester strains had delimited just five reproductively isolated species (Dettman et al. 2003a, 2006, Turner et al. 2001). These 15 phylogenetic species (PS) are referred to two sister clades. The first comprises four of five described species — *N. crassa*, *N. sitophila* (Shear & Dodge 1927), *N. intermedia* and *N. tetrasperma* (Tai 1935) — and three new *Neurospora* species tentatively labeled PS 1, 2 and 3 (Dettman et al. 2003a); Villalta et al. (2009) recently described the new species as *N. hispaniola* (PS1), *N. metzenbergii* (PS2) and *N. perkinsii* (PS3). The second clade comprises the fifth described species — *N. discreta* (Perkins & Raju 1986) — and seven new as-yet undescribed *Neurospora* species tentatively labeled PS 4–10 (Dettman et al. 2006).

Fungi have not been extensively investigated in Iran, and most reports of new taxa are limited to check lists without detailed descriptions. However, fungi of Iran have received more attention in the past few decades. The recent compilations by Ershad (1995) and Abbasi & Aliabadi (2009) of all available

reports on fungal species from different substrates lack any past observation of a *Neurospora* species from Iran.

Materials and methods

The plant material for this investigation was obtained from Gorgan, Golestan province, in the northeast of Iran in the summer of 2008. At the time of sampling, fire burned twigs of plane trees (*Platanus orientalis*) having fungal fruiting bodies on the surface were collected. There were multiple *N. tetrasperma* samples on several twigs from several burnt trees. Specimens of the fungus fruiting bodies were studied in the laboratory using an Olympus light microscope (model BH2). Handmade, thin sections of fruiting bodies were prepared using razor blades and morphological features of the fungus were studied. Also, pieces of plant tissue were placed on water agar (2%) medium after disinfestations and pure fungal cultures were obtained by transferring hyphal tips. Fungal isolates were grown on potato dextrose agar (PDA) culture medium at 25°C under continuous dark condition. Morphological characteristics of sexual and asexual stages of the fungus, as well as growth rates of fungal isolates, were studied. The fungal isolates were identified (based on morphological species concept) by comparison to the descriptions of Perkins & Turner (1988), Turner et al. (2001), and Garcia et al. (2004).

Results

The growth rate of fungus, as measured on PDA at 25°C under continuous dark conditions for 13 hrs, was 0.38 to 0.46 cm/hour. The margins of fungal colonies were smooth or partly irregular. Colony color was white initially, but subsequently, turned to pale orange. The colony expanded quickly and the expanding hyphae were broad, septate, thick-walled, hyaline and branched. Sporodochial tufts, observed only on the plant tissues, were orange in color (FIG. 1A and 1B) with dimensions of 1.2–7.5 × 0.65–2 × 0.32–1.2 mm and were composed of repeatedly branched conidiophores. Conidiophores were at first non-septate and without constrictions, but soon became swollen and septate (FIG. 1C). Conidia were produced at basipetal succession (FIG. 1C). Arthroconidia were subglobose to obovoid, smooth, 8–17 (12.6) × 6–11 (10.5) µm in diameter (FIG. 1E), and appeared orange color in mass. Arthroconidia became swollen and easily separated from each other by dehiscence of the wall and excretion of protoplasmic strands through the central pore of the (double) septa (FIG. 1D). The sexual stage of the fungus was formed abundantly on the culture medium (PDA) and the perithecia were visible on the culture medium and plant tissues (under the bark of tree) as very small black dots (FIG. 2A). Descriptive characteristics of sexual stage of fungus corresponded to those reported by Perkins & Turner (1988), Turner et al. (2001) and Garcia et al. (2004). Perithecia were superficial to somewhat immersed, scattered to aggregated, globose or subglobose with one prominent papilla (FIG. 2B) with 40–70 (54) µm in length. Perithecia were ostiolate, pale brown to dark brown, smooth or

downy with loose hyphae (FIG. 2C), and 300–420 (370) μm in diameter. Asci were unitunicate, hyaline, cylindrical, thin-walled having ring-like thickening at the tip, short stalked, often 4-spored (FIG. 2D), rarely 3-spored and 125–187 (160) \times 15–19 (16) μm in diameter. Ascospores were uniseriate (FIG. 2D), one celled, ellipsoidal or elongated, initially hyaline, becoming yellowish brown to dark brown, ascospore wall surface with longitudinal and sometimes branched ribs (FIG. 2E). Ascospores were 22–41 (32) \times 13–19 (16) μm in diameter and had circular and apical germ pores at each end. Based on morphological features of anamorphic and teleomorphic stages of the fungus on host plant and culture media, it was identified as *Neurospora tetrasperma* Shear & B.O. Dodge (anam. *Chrysonilia tetrasperma* (Shear & B.O. Dodge) Arx).

SPECIMEN EXAMINED— IRAN, Golestan Prov., Gorgan city, near the Varsan village, on fire burned twigs of *Platanus orientalis* L. (*Platanaceae*), 36.835187 °N, 54.317329 °E, 10-VI-2008, Co. AGHAPOUR B (NEU 1154).

Discussion

Neurospora tetrasperma and its related anamorph, *C. tetrasperma*, are reported as new taxa for the mycoflora of Iran. According to the description of Jacobson et al. (2006), the fungus, *N. tetrasperma* (anam. *Chrysonilia tetrasperma*) has been reported in Europe (France and Portugal) from fire burned vegetation. We also looked at the Perkins collection, present at the Fungal Genetic Stock Center (FGSC), with over 4000 *Neurospora* isolates collected by David Perkins worldwide; there were reports of *N. tetrasperma* from Asia (India, Borneo, Indonesia and Malaysia), but none from the Middle East. Our results represent the first occurrence of a *Neurospora* species from Iran. Cannon et al. (1985) and Takeda et al. (2003) have reported *N. tetrasperma* on twigs and leaves of gorse (*Ulex* sp.) and maté (*Ilex paraguariensis* A. St.-Hil.). Our report is a first report on the new host plant, plane tree (*P. orientalis*) in the world.

There are no obvious morphological differences between the reproductive structures of our isolates compared with those described by Perkins & Turner (1988), Turner et al. (2001), and Garcia et al. (2004), except their dimensions, which could be attributed to different hosts and environmental conditions. The *Neurospora* species and their related *Chrysonilia* anamorphs can often be found on the surface following forest or grass fires, as our isolates were obtained from fire burned twigs. Perithecia have been reported under the bark of fire-injured trees (Kitazima 1925, Jacobson et al. 2001), in epidermal tissues of sugar cane stubble (Pandit & Maheshwari 1994, 1996), and on discarded corncobs carrying the yellow ecotype of *N. intermedia* (Pandit et al. 2000). Sexual fruiting bodies have rarely been found in nature at forest fire sites or elsewhere (Jacobson et al. 2003, Pandit & Maheshwari 1996, Perkins 2002). Sexual structures may not have been observed more frequently in the nature



FIG. 1 A-E. Asexual stage of *Neurospora tetrasperma* on *Platanus orientalis* burnt branch: A and B- sporodochia tufts; scale bar= 2 mm. C- conidiophores; scale bar= 100 µm. D- excretion of protoplasmic strands; scale bar= 10 µm. E- conidium; scale bar= 10 µm.

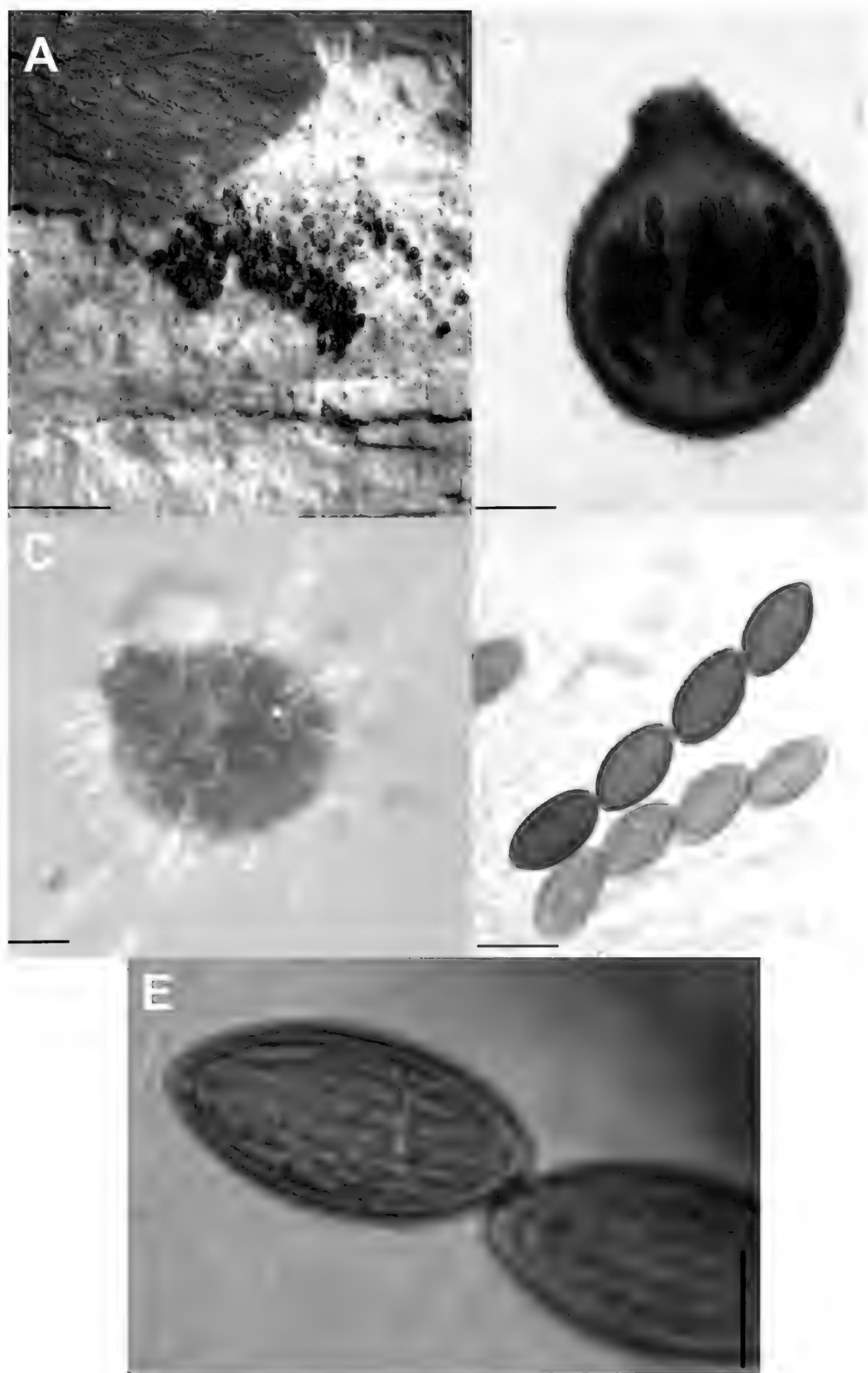


FIG. 2 A–E. sexual stage of *Neurospora tetrasperma* on *Platanus orientalis* burnt branch; A– perithecia scattered to grouped under the bark of *Platanus orientalis*; scale bar= 2 mm. B–perithecia with papilla; scale bar= 100 μ m. C– loose hyphae around perithecia; scale bar= 100 μ m. D– Asci 4-spored; scale bar= 20 μ m. E– ascospore wall with longitudinal ribs; scale bar= 10 μ m.

because of difficulty in recognizing black perithecia on burned substrate or by the perithecia being hidden within the substrate or delay of sexual reproduction until conidial blooms have dispersed (Turner et al. 2001). The role of resistant sexual ascospores in survival, dissemination, and mode of colonization is far from clear (Jacobson 2003). Jacobson et al. (2004, 2006) have observed that *Neurospora* is found growing beneath tree bark in western North America while in Europe it grows on the surface of tree bark. We observed perithecia under the bark of fire burned twigs. It seems that this is the first finding of *N. tetrasperma* perithecia in nature (D.J. Jacobson, pers. comm.).

In the past decade PSR has become a popular alternative to MSR and BSR (Taylor et al. 2000). Recently Menkis et al. (2009) applied both phylogenetic and biological species recognition to a collection of strains representing the geographic and genetic diversity of *N. tetrasperma* and were able to confirm a monophyletic origin of *N. tetrasperma*. Furthermore, they found nine phylogenetic species within the morphospecies and there was a high congruence between the phylogenetic and biological species recognition. Villalta et al. (2009) showed that PSR alone is powerful and accurate it also is important to the formal description of new species to account for reproductive isolation, biogeography, and morphology. We hope to continue our studies on phylogenetic and biological species diversity among reported *N. tetrasperma* strains in Iran in addition with some other collected strains of the fungus from other plants in the future.

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Literature cited

- Abbasi M, Aliabadi F. 2009. The list of fungi reported in proceedings of 12th to 18th Iranian plant protection congress. Elm & Honar Publication, Tehran, 272 p.
- von Arx JA. 1981. On *Monilia sitophila* and some families of ascomycetes. *Sydowia* 34: 13–29.
- Cannon PF, Hawksworth DL, Sherwood-Pike MA. 1985. The British *Ascomycotina*, an annotated checklist. Commonwealth Mycological Institute, Kew, Surrey, England, 302 p.
- Dettman JR, Jacobson DJ, Taylor JW. 2003a. A multilocus genealogical approach to phylogenetic species recognition in the model eukaryote *Neurospora*. *Evolution* 57: 2703–2720.
- Dettman JR, Jacobson DJ, Taylor JW. 2006. Multilocus sequence data reveal extensive phylogenetic species diversity within the *Neurospora discreta* complex. *Mycologia* 98: 436–446.

- Dettman JR, Jacobson DJ, Turner E, Pringle A, Taylor JW. 2003b. Reproductive isolation and phylogenetic divergence in *Neurospora*: comparing methods of species recognition in a model eukaryote. *Evolution* 57: 2721–2741.
- Ershad D. 1995. Fungi of Iran. 2nd Ed. Agricultural Research, Education and Extension Organization, Publication. No. 10, Tehran, 868 p.
- Frederick LF, Uecher FA, Benjamin CP. 1969. A new species of *Neurospora* from soil of West Pakistan. *Mycologia* 61: 1077–1084.
- Garcia D, Stchigel AM, Cano J, Guarro J, Hawksworth DL. 2004. A synopsis and re-circumscription of *Neurospora* (syn. *Gelasinospora*) based on ultrastructural and 28S rDNA sequence. *Mycological Research* 108: 1119–1142.
- Gochenaer SE, Backus MP. 1962. A new species of *Neurospora* from Wisconsin lowland soil. *Mycologia* 54: 555–562.
- Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth and Bisby's Dictionary of the Fungi. 8th Ed. Wallingford, UK, CAB International, 616 p.
- Jacobson DJ. 2003. Will European forest fires favor *Neurospora* ascomata? *Mycological Research* 107: 1250–1251.
- Jacobson DJ, Barton MM, Dettman JR, Hiltz MD, Powell AJ, Saenz GS, Taylor JW, Glass NL, Natvig DO. 2001. *Neurospora* in western North America: a model system in the backyard. *Fungal Genetics Newsletter* 48 (Suppl.): 62. (Abstr.).
- Jacobson DJ, Dettman JR, Adams RI, Bosel C, Sultana S, Roenneberg T, Merrow M, Duarte M, Marques I, Ushakova A, Carneiro P, Videira A. 2006. New findings of *Neurospora* in Europe and comparisons of diversity in temperate climates on continental scales. *Mycologia* 98: 550–559.
- Jacobson DJ, Powell AJ, Dettman JR, Saenz GS, Barton MM, Hiltz MD, Dvorachek WH, Glass NL, Taylor JW, Natvig DO. 2004. *Neurospora* in temperate forests of western North America. *Mycologia* 96: 66–74.
- Kitazima K. 1925. On the fungus luxuriantly grown on the bark of trees injured by the great fire of Tokyo on Sept. 1, 1923. *Annals of the Phytopathology Society of Japan* 1: 15–19.
- Krug JC, Khan RS. 1991. A new homothallic species of *Neurospora* from Hungary. *Mycologia* 83: 829–832.
- Mahoney DP, Huang LH, Backus MP. 1969. New homothallic *Neurospora* from tropical soils. *Mycologia* 61: 264–274.
- Mayr E. 1942. Systematics and the origin of species. Columbia University Press, New York, 368 p.
- Menkis A, Bastiaans E, Jacobson DJ, Johannesson H. 2009. Phylogenetic and biological species diversity within the *Neurospora tetrasperma* complex. *Journal of Evolutionary Biology* 22: 1923–1936.
- Nelson AC, Novak RO, Backus MP. 1964. A new species of *Neurospora* from soil. *Mycologia* 56: 384–392.
- Pandit A, Dubey PS, Mall S. 2000. Sexual reproduction of the yellow ecotype of *Neurospora intermedia* in nature. *Fungal Genetics Newsletter* 47:81–82.
- Pandit A, Maheshwari R. 1994. Sexual reproduction by *Neurospora* in nature. *Fungal Genetics Newsletter* 41: 67–68.
- Pandit A, Maheshwari R. 1996. Life history of *Neurospora intermedia* in a sugar cane field. *Journal of Biosciences* 21: 57–79.
- Perkins DD. 2002. *Neurospora* perithecia: the first sighting. *Fungal Genetics Newsletter* 49: 9–10.
- Perkins DD, Raju NB. 1986. *Neurospora discreta*, a new heterothallic species defined by its crossing behavior. *Experimental Mycology* 10: 323–338.

- Perkins DD, Turner BC. 1988. *Neurospora* from natural populations: toward the population biology of a haploid eukaryote. *Experimental Mycology* 12: 91–131.
- Shear CL, Dodge BO. 1927. Life histories and heterothallism of the red bread-mold fungi of the *Monilia sitophila* group. *Journal of Agricultural Research* 34: 1019–1042.
- Tai FL. 1935. Two new species of *Neurospora*. *Mycologia* 27: 328–330.
- Takeda I, Guerrero R, Bettucci L. 2003. Endophytic fungi of twigs and leaves from *Ilex paraguariensis* in Brazil. *Sydowia* 55: 372–380.
- Taylor JW, Jacobson DJ, Kroken S, Kasuga T, Geiser DM, Hibbett DS, Fisher MC. 2000. Phylogenetic species recognition and species concepts in Fungi. *Fungal Genetics and Biology* 31: 21–32.
- Turner BC, Perkins DD, Fairfield A. 2001. *Neurospora* from natural populations: a global study. *Fungal Genetics and Biology* 32: 67–92.
- Villalta CF, Jacobson DJ, Taylor JW. 2009. Three new phylogenetic and biological *Neurospora* species: *N. hispaniola*, *N. metzenbergii* and *N. perkinsii*. *Mycologia* 101: 777–789.

Lichenized and lichenicolous fungi from nine different areas in Turkey

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Abstract — A contribution to the lichen flora of Turkey is presented. The taxonomic survey of Ankara, Erzurum, Hatay, Ordu, Siirt, Uşak regions, and Kınalıada, Heybeliada and Marmara islands yields a total of 297 lichenized and 14 lichenicolous fungi representing 93 genera in the *Ascomycota*. *Aspicilia moenium*, *Lecanora albellula*, *Pertusaria pupillaris*, *Porina aenea*, and *Rinodina fatiscens* are new to Turkey. Distribution and substrata are cited in the complete annotated list, which can be downloaded from <http://www.mycotaxon.com/resources/weblists.html>.

Keywords — *Ascomycetes*, biodiversity, lichens

Introduction

In recent years there has been an increasing number of studies on the lichen flora of Turkey (Aptroot & Yazici 2009, Candan & Özdemir Türk 2008, Yazici & Aptroot 2008, Yazici & Aslan 2009). However, compared to other countries, many regions of Turkey remain unexplored. Although recent lichenological research has been conducted for Ankara, Erzurum, Hatay, Ordu and Uşak regions, and Kınalıada and Heybeliada islands (Aslan 2000, Çobanoğlu & Akdemir 1997, John 2002, John et al. 2000, John & Nimis 1998, Kinalioglu

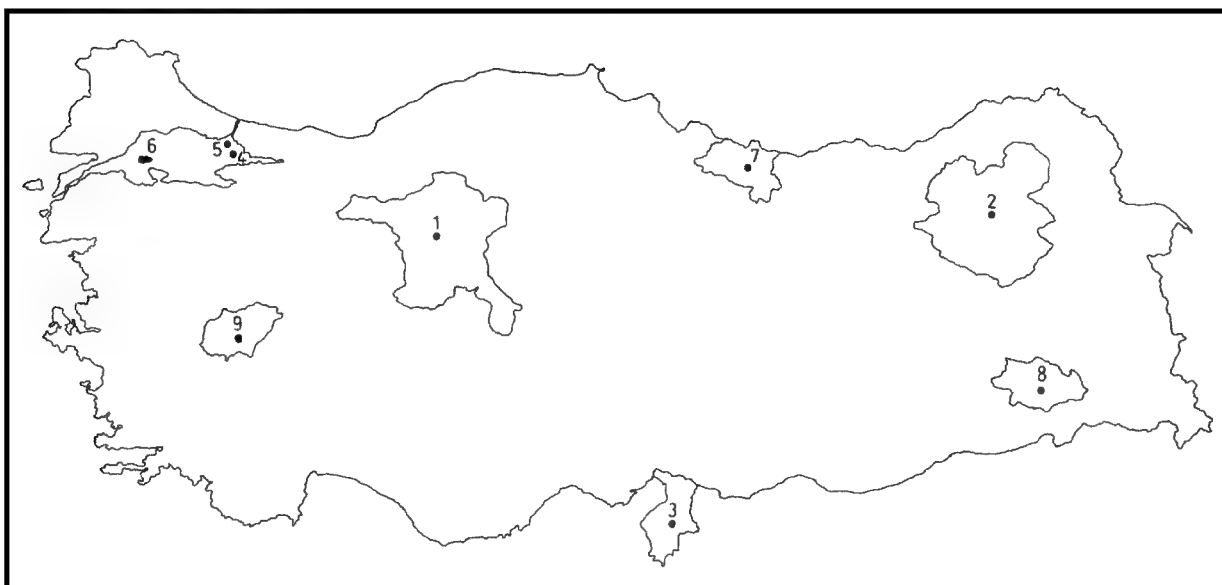


FIGURE 1. Map of Turkey showing the nine areas surveyed in this paper. 1: Ankara, 2: Erzurum, 3: Hatay, 4: Heybeliada, 5: Kınalıada, 6: Marmara Island, 7: Ordu, 8: Siirt, 9: Uşak

2008), no lichens and lichenicolous fungi have thus far been reported for Siirt region and Marmara island. The present paper adds further information to our knowledge of the lichen flora of Turkey.

Material and methods

The lichen samples were collected in 40 different localities from 16 April 2007 to 21 March 2009. The study area consists of Ankara, Erzurum, Hatay, Ordu and Uşak regions, and Kınalıada and Heybeliada islands of Turkey (FIG. 1). Air-dried samples were studied with a Nikon SMZ1500 stereomicroscope and a Nikon Eclipse 80i light microscope with standard identification methods for lichenized and lichenicolous fungi (Etayo & Sancho 2008, Poelt 1969, Purvis et al 1992, Wirth 1995). Vouchers are deposited in the herbarium of Biology Department, Faculty of Science, Karadeniz Technical University, Turkey (KTUB).

Ankara is mostly surrounded mostly by steppe vegetation and has a harsh dry continental climate with cold, snowy winters and hot, dry summers.

Continental climate dominates in Erzurum with long and harsh winters, and short, mild summers. The average minimum temperature is -8.6°C , while the average high temperature is 19.6°C . Average annual precipitation is 453 mm. Steppe formations are prevalent.

In Uşak the Mediterranean climate is predominant and characterized by hot and dry summers and cold winters with much snowfall. Annual rainfall is 557 mm. The annual mean temperature is 12.5°C . *Quercus cerris*, *Q. infectoria*, *Pinus brutia*, and *P. sylvestris* are abundant trees.

Ordu is relatively dry, and has a Mediterranean climate. The flora mix with conifers that occur between the forests and platforms (Akman 1999, Baytop & Denizci 1963).

The Mediterranean climate prevails in Hatay. Winters are warm and rainy while summers are hot and dry. Annual average temperature is between $16-21^{\circ}\text{C}$. Annual

average rainfall varies between the 570-1174 mm Natural flora consists of maquis and forests with deciduous trees (i.e. *Juniperus*, *Quercus*, *Betula*, *Populus*, *Platanus*).

Siirt region is well-forested and mountainous northeast of the city and gives way to a series of broad plateaus with steppe vegetation in the south. Terrestrial climate dominates in Siirt.

Kınalıada is the nearest island to the Asian side of Istanbul. The steppe is predominant. The annual average temperature fluctuates between 15–16°C. It has an intermediate climate. The highest annual average rainfall is in May (638.5 mm).

In Marmara Island *Pinus brutia* is predominantly seen from time to time while maquis is dominating in the south. The summers are dry and cool, the winters wet. Marmara has a mediterranean climate that is characterized by warm to hot summers (Akman 1999, Baytop & Denizci 1963).

Results

The taxonomic survey of Ankara, Erzurum, Hatay, Ordu, Siirt, Uşak regions, and Kınalıada, Heybeliada and Marmara islands yielded 297 lichenized and 14 lichenicolous fungi (i.e., 305 species, 4 subspecies, 2 varieties) representing 93 genera in the *Ascomycota*. Of these, 138 taxa were collected in Ankara, 156 in Hatay, 120 in Ordu, 111 in Uşak, 30 in Siirt, 49 in Erzurum regions, and 29 in Heybeli, 13 in Kınalıada, 64 in Marmara islands. *Aspicilia moenium*, *Lecanora albellula*, *Pertusaria pupillaris*, *Porina aenea*, and *Rinodina fatiscens* are new to Turkey. New records per province include 89 taxa from Ankara. Moreover, 94 taxa were reported as new from Ordu, 63 lichenized and 2 lichenicolous fungi from Uşak, 52 from Hatay, 22 from Erzurum, 27 from Heybeliada island, 11 from Kınalıada islands while all taxa identified are new for Siirt region (30 taxa) and Marmara island (64 taxa).

Discussion

Besides lichenicolous fungi (14 taxa), 178 species of the 297 taxa are crustose, 82 foliose, 34 fruticose, and 3 leprose. Further, 112 taxa were epiphytic only, 144 saxicolous, 20 terricolous, 12 epiphytic or saxicolous, 5 terricolous and muscicolous, and 21 muscicolous only. On the other hand, 8 taxa were defined parasitically growing on lichenized fungi. (of these 5 are strictly lichenicolous fungi). These are *Arthonia phaeophysciae*, *Buellia badia*, *Caloplaca aractina* (lichen), *Caloplaca grimmiae*, *Candelariella vitellina* (lichen), *Carbonea vitellinaria*, *Lecanora albescens* (lichen) and *Opegrapha glaucomaria*. *Caloplaca*, *Cladonia*, *Lecanora*, *Rinodina*, *Verrucaria* and *Xanthoparmelia* are the common genera in the area. Foliose genera such as *Flavoparmelia*, *Parmelia*, *Phaeophyscia*, *Physcia*, *Physconia*, *Melanelixia*, *Melanohalea*, *Peltigera*, *Xanthoparmelia* and *Xanthoria* were mostly found in Ankara, Hatay and Ordu regions. *Phaeophyscia*, *Physcia* and *Physconia* were mostly found in Ankara and Ordu especially on

deciduous trees. Saxicolous crustose lichens were found at all the stations and were very common, especially in the Ankara, Erzurum, and Siirt regions and on Marmara island. Crustose species were seen nearly at all stations and were very common on rock, limestone, and deciduous trees in Ankara, Hatay, Odu, Siirt, and Uşak. Foliose genera were mostly found in Ankara, Hatay, and Ordu. Fruticose taxa were mostly found in Ordu, Hatay, and Uşak.

Acknowledgments

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Literature cited

- Akman Y. 1999. Climate and Bioclimate (The Methods of Bioclimate and Climate Types of Turkey). 1st Edn., Kariyer Matbaacılık Ltd., Şti, Ankara.
- Aptroot A, Yazici K. 2009. *Opegrapha pauciexcipulata*, a new corticolous lichen from Turkey. Mycotaxon 108: 155–158.
- Aslan A. 2000. Lichens from the regions of Artvin, Erzurum and Kars. Israel J of Plant Sci. 48: 143–155.
- Baytop A, Denizci R. 1963. Türkiye'nin Flora ve Vejetasyonuna Genel Bir Bakış. Ege Üniv. Fen Fak. Monografiler Ser. 1, Ege Üniv. Mat., İzmir.
- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). Mycotaxon 105: 19–22.
- Çobanoğlu G, Akdemir B. 1997. A taxonomic survey on lichens of İstanbul Islands (Kınalı, Burgaz, Heybeli, Büyükkada). Proceedings of the Second International Scientific Conference, Cairo, 17–20 March, 1997. pp. 497–509.
- Etayo J, Sancho LG. 2008. Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). Bibl. Lichenol. 98: 1–302.
- John V. 2002. Lichenes Anatolici exsiccati Fasc. 6–7: 126–175.
- John V, Seaward MRD, Beatty JW. 2000. A neglected lichen collection from Turkey: Berkhamsted Scholl Expedition 1971. T J Bot. 24: 239–248.
- John V, Nimis PL. 1998. Lichen flora of Amanos Mountain and the province of Hatay. Tr. J. Bot. 22: 257–267.
- Kinalioglu K. 2008. Floristic lichen records from Uşak province, Turkey. International J. Bot. 4(4): 444–449.
- Poelt J. 1969. Bestimmungsschlüssel europäischer Flechten. Cramer, Lehre.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The lichen flora of Great Britain and Ireland. Natural History Museum Publications & The British Lichen Society, London.
- Yazici K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. Mycotaxon 105: 95–104.
- Yazici K, Aslan A. 2009. Lichen species new to Turkey and Asia. Mycotaxon 108: 463–466.
- Wirth V. 1995. Die Flechten Baden-Württembergs. Teil 1–2. Ulmer, Stuttgart.

Two new species of *Humicola* from soil

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Abstract — Two new species of *Humicola* from soil in China, *H. interseminata* and *H. macrospora*, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Plant Pathology Herbarium of Shandong Agricultural University (HSAUP).

Key words — anamorphic fungi, taxonomy

Introduction

The genus *Humicola* was established by Traaen (1914) for two species with hyaline hyphae: the type species, *Humicola fuscoatra*, and *H. grisea*. Later, more species were found, although those with pigmented hyphae did not fit within Traaen's original circumscription. Fassatiová (1967) emended the original generic diagnosis, pointing out that taxonomic opinion no longer considered pigment a decisive feature (Hughes 1953, Subramanian 1962). In addition, she emphasized that only strains in which aleuriospores are dominant in the culture can be included in this genus. Bertoldi (1976) concluded that aleuriospore size is the most effective and stable diagnostic morphological character in *Humicola*. By 2006, no fewer than 50 taxa of this genus had been reported in the world (<http://www.indexfungorum.org/Names/Names.asp>).

During an investigation of soil dematiaceous hyphomycetes in southwest China, one fungus obtained from a rice field and another from forest soil possessed the typical *Humicola* characters but did not match other similar species in this genus. These two fungi are described as new species.

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Taxonomic descriptions

Humicola interseminata Y.L. Jiang & T.Y. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 515212

Coloniae effusae, griseo-brunneae, reverse atro-brunneae. Mycelium superficiale vel immersum. Hyphae subhyalinae vel pallide flavo-brunneae, ramosae, septatae, laeves, 1–3 μm crassae. Conidia globosa, singulatim directe nata in vegetalibus hyphis vel in brevibus lateralibus conidiophoris, unicellularia, laevia, pallide flavo-brunnea vel flavo-brunnea, 3–7.5 (plerumque 5.1) μm in diametro. Intercalares, globosa chlamydosporae producuntur. Phialosporae non visae.

HOLOTYPE: from soil of a rice field in Wuchang, Hubei Province, China. Oct. 13. 2004, Y. L. Jiang, HSAUP II₀₄6108, dried culture (holotype), and ex-type living culture.

ETYMOLOGY: in reference to its habitat.

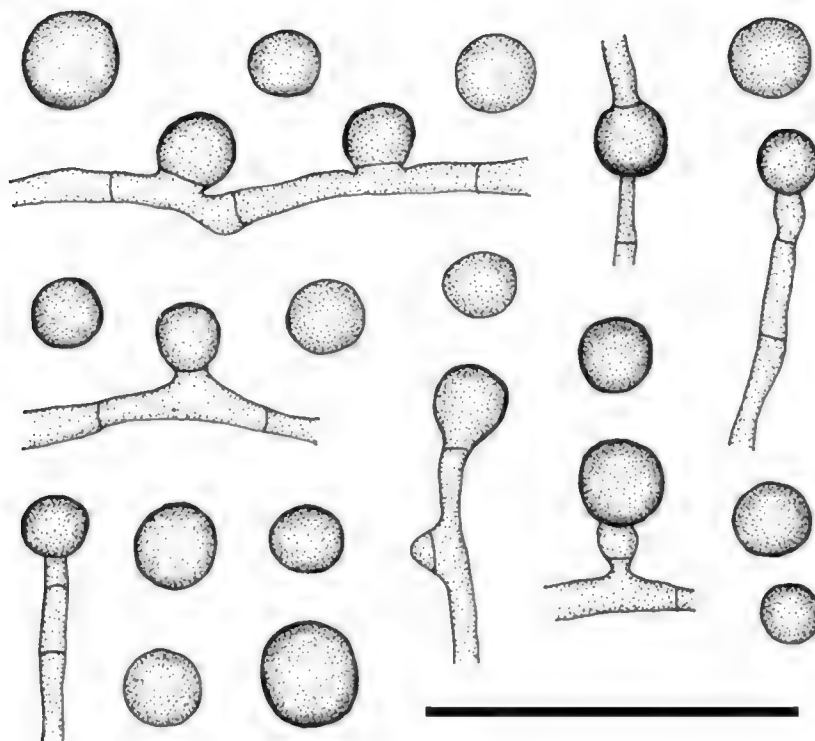


FIG. 1 Conidia and conidiophores of *Humicola interseminata*
(Bar = 25 μm)

Colonies on PDA effuse, greyish brown, reverse dark brown. Mycelium superficial and immersed: hyphae subhyaline to pale yellowish brown, branched, septate, smooth, 1–3 μm wide. Conidia globose, with a scar at the base of free spores, produced singly either directly on the sides of vegetative hyphae or on short lateral conidiophores, unicellular, smooth, pale yellowish brown to yellowish brown, 3–7.5 (commonly 5.1) μm in diameter. Intercalary, globose chlamydospores are produced. Phialospores not seen.

COMMENTS: The species most similar to *H. interseminata* are *H. indica* S.C. Agarwal (Agarwal 1983; nom. illegit., non Haware & Pavgi 1971) and *H. nivea*

De Bertoldi (De Bertoldi 1976). However, *H. interseminata* produces only globose conidia while *H. indica* produces both globose and elliptical conidia. Conidia of *H. interseminata* are solitary while those of *H. indica* sometimes occur in groups. Also, *H. interseminata*, unlike *H. indica*, produces intercalary chlamydospores.

Humicola interseminata is distinguished from *H. nivea* by conidial size and ornamentation, with the conidia of *H. nivea* larger (8.9–9.4 μm) and sometimes with slightly roughened walls.

***Humicola macrospora* Y.L. Jiang & T.Y. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 515213

Coloniae effusae, lanosae rufo-brunneae, reverse atro rufo-brunneae. Mycelium superficiale vel immerse. Hyphae ramosae, septatae, laeves, subhyalinae vel pallide auratae, 1–3 μm latae. Conidiophora pallide aurata vel aurata, ramosa, septata, laevia, 5–13 μm crassa. Conidia globosa, solitaria vel in brevicatenatis, directe nata in vegetalibus hyphis vel in lateralibus conidiophoris, unicellulares, laevia, aurea, crasse tunicata, 15–37 (vulgo 26) μm in diametro. Intercalares, globosa chlamydosporae producuntur. Phialosporae non visae.

HOLOTYPE: from a soil of Emei Mountain, Sichuan Province, China. Aug. 9. 2005, Y.L. Jiang, HSAUP II₀₅0911, dried culture (holotype), and ex-type living culture.

ETYMOLOGY: in reference to the large conidia.

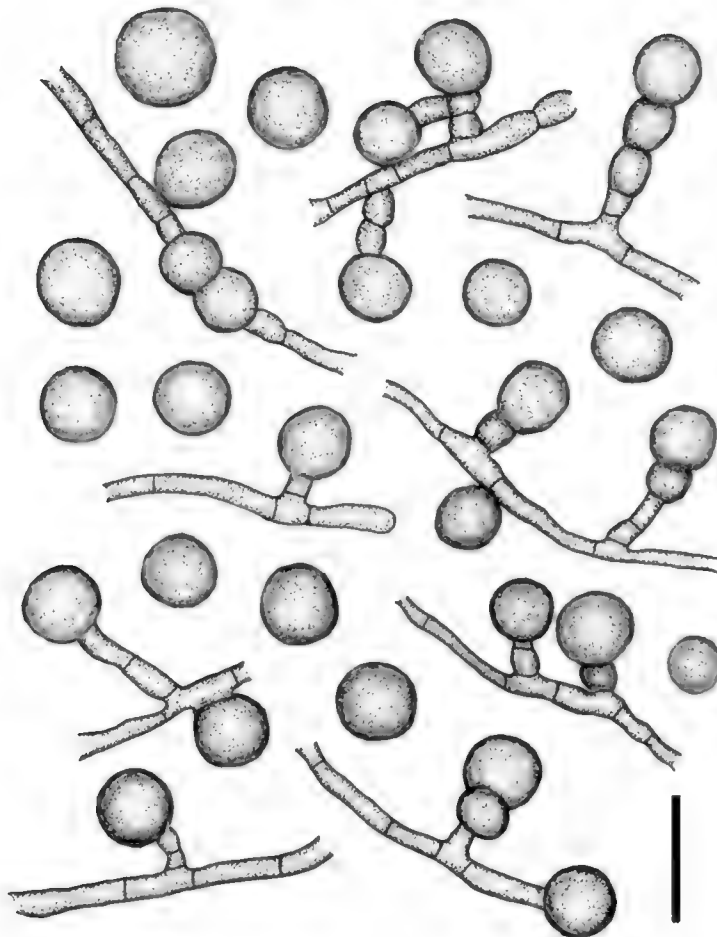


FIG. 2 Conidia and conidiophores of *Humicola macrospora*
(Bar = 50 μm)

Colonies on PDA effuse, cottony, reddish brown, darker in reverse. Mycelium superficial and immersed: hyphae branched, septate, smooth, subhyaline to pale golden yellow, 1–3 μm wide. Conidiophores pale golden yellow to golden yellow, branched, septate, smooth, 5–13 μm wide. Conidia globose, solitary or forming short chains, produced either directly on the sides of vegetative hyphae or on lateral conidiophores, unicellular, smooth, golden yellow, thick-walled, 15–37 (commonly 26) μm in diameter. Intercalary, globose chlamydospores are produced. Phialospores not seen.

COMMENTS: *Humicola macrospora* differs from all other described species in the genus in its large, golden yellow conidia and reddish brown colonies on PDA.

Acknowledgments

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Literature cited

- Agarwal SC. 1983 ("1982"). A new species of *Humicola* from Indian alkaline soils. Indian J. Mycol. Plant Pathol. 12(2): 222–223.
- De Bertoldi M. 1976. New species of *Humicola*: an approach to genetic and biochemical classification. Can. J. Bot. 54: 2755–2768.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, Surrey, England. 1–608.
- Fassatiová O. 1967. Notes on the genus *Humicola* Traaen. II. Česká Mykologie 21(2): 78–89.
- Hughes SJ. 1953. Conidiophores, conidia and classification. Can. J. Bot. 31: 577–659.
- Roxon JE, Jong SC. 1974. A new pleomorphic species of *Humicola* from Saskatchewan soil. Can. J. Bot. 52: 517–520.
- Subramanian CV. 1962. The classification of the *Hyphomycetes*. Bull. Bot. Surv. India 4: 249–259.
- Traaen EA. 1914. Untersuchungen über die Bodenpilze aus Norwegen. Nyt. Mag. Naturvid. 32: 20–121.

***Leucoagaricus orientiflavus*, a new yellow lepiotoid species from southwestern China**

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Abstract — *Leucoagaricus orientiflavus* is described as new from southwestern China. It is characterized by a yellow pileus lacking plicate striations toward the margin, pure white lamellae, yellowish stipe and context, subamygdaliform basidiospores that are dextrinoid and lack a germ pore, cylindrico-clavate cheilocystidia, and a cutis-type pileipellis made up of radially arranged subcylindrical hyphae.

Key words — *Agaricales*, lepiotaceous fungi, morphology, systematics, taxonomy

Introduction

The genus *Leucoagaricus* Locq. ex Singer (*Agaricaceae*, *Agaricales*, *Basidiomycota*) is regarded to be a genus intermediate between the genera *Macrolepiota* Singer and *Leucocoprinus* Pat. Morphologically, species within *Leucoagaricus* can be recognized by the following combination of characters: surface of the pileus scaly-excoriated or even, fibrillose, pubescent or glabrous, not sulcate or sulcate only at the margin; spore print white, cream to pink; spores usually less than 10 µm, dextrinoid, metachromatic in cresyl blue; hymenium without conspicuous pseudoparaphyses; and hyphae in the trama of the pileus and stipe without clamp connections. *Leucoagaricus* differs from *Macrolepiota* by having relatively slender basidiomata and in lacking clamp connections in the trama of the pileus and stipe. *Leucoagaricus* can be distinguished from *Leucocoprinus* because *Leucocoprinus* has notable striations on the pileus, pseudoparaphyses in the hymenium, and spores that usually have a germ pore (Singer 1986). *Leucoagaricus* has received much attention in recent years worldwide (Akers et al. 2000; Akers & Ovrebo 2005; Didukh et al. 2003; Hausknecht & Pidlich-Aigner 2004; Kumar & Manimohan 2009; Ortiz et al. 2008; Rother & da Silva

2009; Vellinga 2000, 2004, 2007; Vellinga & Davis 2007; Wasser 1993), and a few new species have been described. In this paper a newly discovered yellow species of *Leucoagaricus* from southwestern China is described.

Materials and methods

The examined materials were collected in Kunming (southwestern China, Asia), and deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS/KUN). Macroscopic characters were examined on fresh basidiomata. Color notations indicated in the description are from Kornerup & Wanscher (1978). Micromorphology is based on observation of the material under a light microscope at 1000 \times . Tissues were sectioned by hand and mounted in 5% KOH, and pileal structure, cheilocystidia, basidia, and basidiospores were observed. KOH mounts were then stained with Congo Red for the preparation of line drawings. Melzer's reagent was used to test the amyloidy of spores, and spore wall reactions were checked in Cresyl Blue and Cotton Blue. At least 20 basidiospores were measured for each collection; the notation [60/3/2] indicates 60 spores measured from 3 fruit bodies in 2 collections. Dimensions for basidiospores are given using notation of form (a-)b-c(-d), with b-c containing a minimum of 90% of all values measured. Extreme values (a and d) are given in parentheses. Q indicates length/width ratio of a spore measured in side view with avQ denoting the average Q of all basidiospores \pm sample standard deviation. nrITS sequences generated for the collections are deposited in GenBank and listed with the collections.

Taxonomy

Leucoagaricus orientiflavus Z.W. Ge, sp. nov.

FIGURE 1

MYCOBANK MB 515274; GENBANK nrITS GU084262

Pileus 30–80 mm *latus*, *primo ovoideus*, *deinde convexus et convexo-applanatus*, *glaber*, *raro rugulosus*, *luteolus*, *pallide flavus vel flavus*. *Lamellae liberae, albae, confertae*. *Stipes* 50–105 \times 6–13 mm, *subflavus vel flavo-albidus*. *Sporae* (6.0–)6.5–7.5 \times (3.0–)3.5–4.0 μ m, *amygdaliformiae*. *Basidia* 17–24 \times 6–7.5 μ m, *clavata*, *4-sporigera*. *Acies lamellarum sterilis*. *Cheilocystidia* 28–43 \times 9.0–11.0 μ m, *cylindrico-clavata vel anguste clavata*. *Pleurocystidia nulla*. *Trama hymenophoralis subregularis, hyalina*. *Squamulae pilei ex epicute e hyphis repentibus, subcylindricis compositae*. *Caro flavo-albida*. *Fibulae abscentes*. *Habitatio: terrestris*.

HOLOTYPE: China, Yunnan Province, Kunming, Heilongtan: 22 July 2008, Z.W. Ge 2063 (HKAS 54260) (GenBank nrITS GU084262).

ETYMOLOGY: *orienti-* refers to the type locality and *-flavus* refers to the color of this fungus.

BASIDIOMATA (FIG. 1a) medium sized. **PILEUS** 30–80 mm in diam., ovoid when young, becoming convex to broadly convex and finally plano-convex, without an umbo; surface dry, slightly viscid when wet, pastel yellow (2A4), light yellow (2A5), yellow (2A6–2A7) to vivid yellow (2A8); yellowish white (2A2) towards margin, smooth, occasionally somewhat rugose; margin entire to slightly

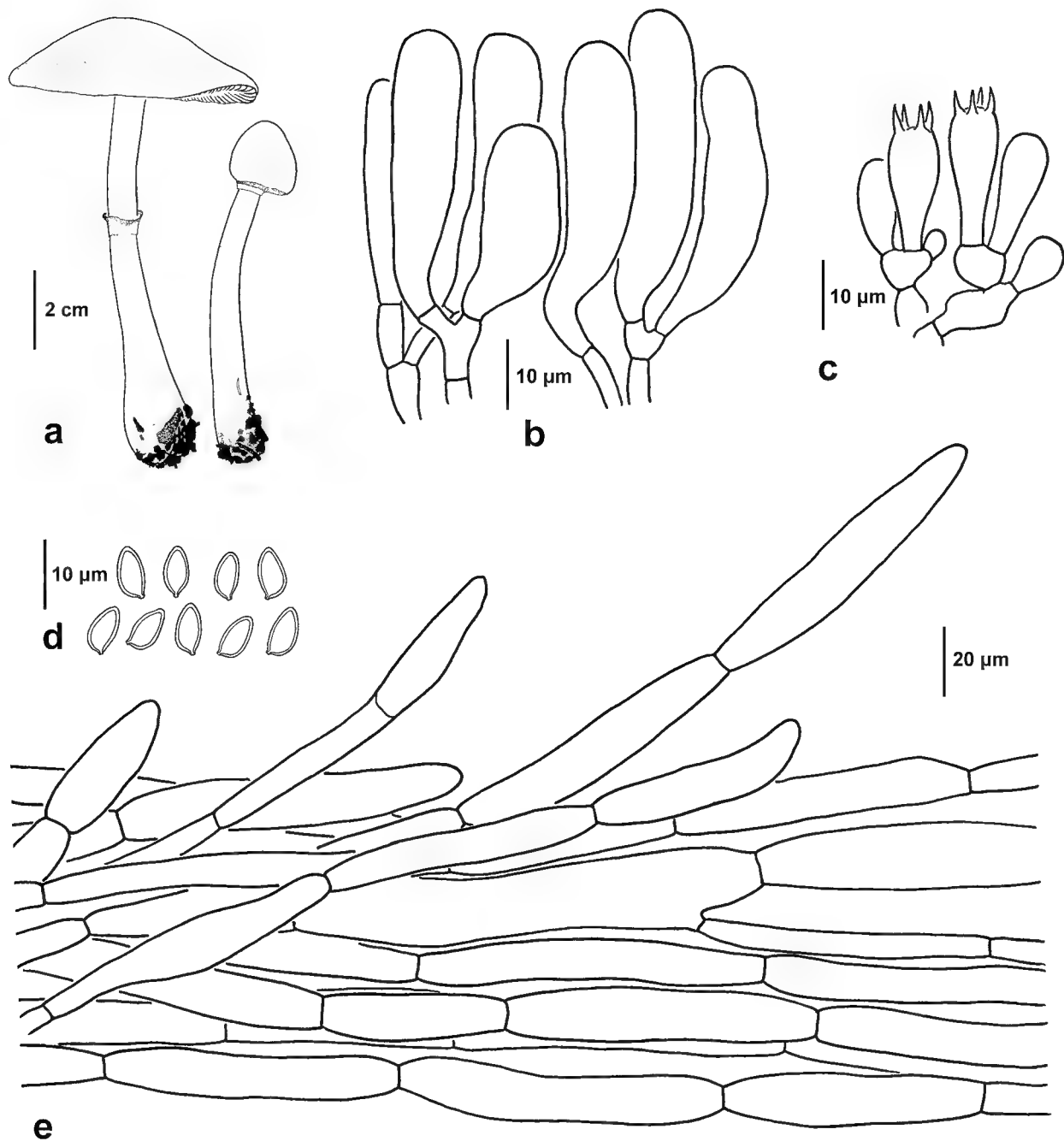


FIG. 1. *Leucoagaricus orientiflavus* (holotype).

a. Basidiomata; b. Cheilocystidia; c. Basidia; d. Basidiospores; e. Pileus covering.

crenate. LAMELLAE free, remote from the stipe, pure white, close to crowded, up to 7 mm wide, with lamellulae in 2–3 tiers; edge even to naked eye, fimbriate under a lens, concolorous with the faces. STIPE cylindrical, 50–105 × 6–13 mm, central, slightly expanded towards the base (up to 13 mm wide), solid when young, becoming fistulose and finally hollow with age; surface yellowish to yellowish white, smooth, somewhat fibrillose under lens. ANNULUS median, membranous, soft, persistent, yellowish white, fixed. CONTEXT thin, yellowish white (2A2) to yellow (2A6) in both pileus and stipe, up to 4 mm thick in pileus. ODOR not distinctive. SPORE PRINT white.

BASIDIOSPORES (FIG. 1d) [60/3/2] (6.0–)6.5–7.5 \times (3.0–)3.5–4.0 μm , $Q = 1.63\text{--}1.88$ (2.17), $avQ = 1.84 \pm 0.156$, amygdaliform in side view, narrowly ovoid in frontal view, hyaline, with refractive guttules, slightly thick-walled, smooth, without germ pore, dextrinoid, metachromatic in Cresyl Blue, cyanophilous in Cotton Blue. SUBHYMENIUM composed of irregularly inflated cellular hyphae. BASIDIA (FIG. 1c) 17–24 \times 6–7.5 μm , clavate, hyaline, with guttulate contents, bearing 4 sterigmata up to 3 μm long. Pseudoparaphyses not observed. CHEILOCYSTIDIA (FIG. 1b) abundant, forming a sterile edge, 28–43 \times 9.0–11.0 μm , cylindrico-clavate to narrowly clavate, occasionally with a median constriction, hyaline, thin-walled. PLEUROCYSTIDIA absent. LAMELLAR TRAMA subregular; hyphae 4–8 μm , hyaline, thin-walled, often pale yellowish walled. PILEUS COVERING (Fig. 1e) a cutis of appressed, radially arranged subcylindrical hyphae sometimes branched, with elements measuring (50–)85–115 \times (8–)11–15 (–17) μm , thin-walled, hyaline to pale yellow, occasionally disrupted by ascending, more or less pointed terminal elements, without globose elements. PILEAL TRAMA interwoven; hyphae 8–22 μm wide, cylindrical, septate, hyaline, thin-walled to slightly thick-walled. STIPE COVERING similar to pileal covering, composed of a cutis of loosely arranged cylindrical hyphae around 7–10 (–18) μm wide, hyaline to pale yellowish, slightly thick-walled. CLAMP CONNECTIONS not observed in any hypha examined.

HABITAT AND DISTRIBUTION: Saprotrophic and terrestrial on clayey soils, scattered or in small groups, not in clusters. So far only known from the type locality, Kunming, Yunnan province, China.

ADDITIONAL COLLECTIONS EXAMINED — CHINA, YUNNAN PROVINCE, Kunming, KUNMING BOTANICAL GARDEN: 25 July 2008, Z.W. Ge 2068 (HKAS 54265) (GenBank nrITS GU084261).

COMMENTS: *Leucoagaricus orientiflavus* is clearly delimited by a unique combination of characters. Macroscopically, it has a yellow pileus that lacks marginal striations, pure white lamellae, a yellowish stipe, and yellowish to yellow context. Microscopically, it bears dextrinoid amygdaliform spores without a germ pore, cylindrico-clavate to narrowly clavate cheilocystidia, a cutis-type pileal covering composed of appressed, radially arranged subcylindrical hyphae, and lacks clamp connections.

Infrageneric classifications of *Leucoagaricus* are not consistent. Singer (1986) recognized six sections within this genus and regarded *Sericeomyces* Heinem. as a separate genus. Bon (1981) regarded *Sericeomyces* as a subgenus within *Leucoagaricus*, a classification now accepted by most mycologists (e.g., Candusso & Lanzoni 1990, Vellinga 2000).

ITS sequence data (Z.W. Ge, unpublished data) show *Leucoagaricus orientiflavus* as phylogenetically closely related to *La. serenus* (Fr.) Bon & Boiffard, the type species of subgenus *Sericeomyces*. *Leucoagaricus orientiflavus*

and *La. serenus* share similar microscopic characters, including a pileal cutis of subcylindric repent hyphae and amygdaliform spores. However, *La. orientiflavus* is easily distinguished from the white *La. serenus* by its yellow pileus and stipe as well as by its cylindrico-clavate to narrowly clavate cheilocystidia (Candusso & Lanzoni 1990, Vellinga 2000).

Leucoagaricus medioflavoides Bon, another closely related species, differs in having a much smaller (1–2 cm), a paler pileus that is yellowish only near the center, smaller ($5\text{--}6 \times 3.0\text{--}3.5 \mu\text{m}$) ovoid-ellipsoid basidiospores, and long cylindrico-clavate to flexuous cheilocystidia (Bon 1996, Candusso & Lanzoni 1990, Grilli 1989). In addition, *La. orientiflavus* has obvious yellowish to yellow context in both pileus and stipe, a character not recorded for *La. medioflavoides* (Bon 1996, Candusso & Lanzoni 1990, Grilli 1989).

Leucoagaricus subflavus T.K.A. Kumar & Manim. is a recently described yellowish species from India that is similar to *La. orientiflavus*. However, *La. subflavus* has distinctively smaller basidiomata (10–22 mm in diam.) with whitish stipes, smaller spores ($5.5 \pm 0.8 \times 3 \pm 0.2 \mu\text{m}$, $Q = 1.6\text{--}2.3$), and a pileus with scattered recurved squamules and a sulcate-striate margin (Kumar & Manimohan 2009).

Several other species with yellowish to yellow basidiomata in the genus *Leucocoprinus* resemble *La. orientiflavus*. *Leucocoprinus birnbaumii* (Corda) Singer has similarly yellow basidiomata but differs in its flocculose squamules and long striations towards the pileal margin, much bigger spores with an obvious germ pore, and lageniform to utriform cheilocystidia (Candusso & Lanzoni 1990).

Leucocoprinus flavus (Beeli) Heinem., originally described from tropical Africa, differs from *La. orientiflavus* in possessing whitish to pale yellow lamellae, whitish context both in the pileus and stipe, and a strong fruity smell. Microscopically, *Lc. flavus* has larger oblong spores ($8.3 \times 4.3 \mu\text{m}$) and variously clavate to sublageniform cheilocystidia that are sometimes apically encrusted with fine crystals (Candusso & Lanzoni 1990, Vizzini & Miglioizzi 2007).

Leucocoprinus straminellus (Bagl.) Narducci & Caroti, originally described from Europe, also has yellowish basidiomata and spores without a germ pore. However, the basidiomata of *Lc. straminellus* are more often pale lemon yellow, the spores are broadly ellipsoid to ellipsoid, and the versiform cheilocystidia range from lageniform to clavate cylindrical to cylindrical. In addition, the pileus has long striations towards the margin and is covered by floccose to fine granulose veil remnants (Candusso & Lanzoni 1990).

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Literature cited

- Akers BP, Angels SA, Kimbrough JM. 2000. *Leucoagaricus viridiflavoides*, a new species from Florida, with notes on related taxa. *Mycotaxon* 76: 39–50.
- Akers BP, Ovrebo CL. 2005. *Leucoagaricus bivelatus*, a new volvate lepiotoid species. *Mycotaxon* 91: 303–308.
- Bon M. 1981. Clé monographique des ‘Lépiotes’ d’Europe. *Doc. Mycol.* 11(43): 1–77.
- Bon M. 1996. Die Grosspilzflora von Europa. *Lepiotaceae*. IHW-Verlag, Germany.
- Candusso M, Lanzoni G. 1990. *Fungi Europaei* 4. *Lepiota* s. l. Saronno: Giovanna Biella.
- Didukh M, Wasser SP, Nevo E, Ur Y. 2003. New records of *Leucocoprineae* and *Lepioteae* (*Basidiomycotina*, *Agaricales* s. l.) in Israel. *Doc. Mycol.* 23(126): 39–58.
- Grilli G. 1989. New or interesting *Agaricales* from central Italy. *Leucoagaricus medioflavoides* Bon *deceptivus* Grilli nov. var. *Micologia e Vegetazione Mediterranea* 4(1): 3–10.
- Hausknecht A, Pidlich-Aigner H. 2004. *Lepiotaceae* (Schirmlinge) in Österreich. 1. Die Gattungen *Chamaemyces*, *Chlorophyllum*, *Cystolepiota*, *Leucoagaricus*, *Leucocoprinus*, *Macrolepiota*, *Melanophyllum* und *Sericeomyces*. *Österr. Z. Pilzk.* 13: 1–38.
- Kornerup A, Wanscher JH. 1978. *Methuen handbook of colour*. 3rd ed. London: Eyre Methuen Ltd.
- Kumar TKA, Manimohan P. 2009. The genera *Leucoagaricus* and *Leucocoprinus* (*Agaricales*, *Basidiomycota*) in Kerala State, India. *Mycotaxon* 108: 385–428.
- Ortiz A, Franco-Molano AE, Bacci M Jr. 2008. A new species of *Leucoagaricus* (*Agaricaceae*) from Colombia. *Mycotaxon* 106: 371–378.
- Rother MS, da Silveira RMB. 2009. *Leucoagaricus lilaceus* (*Agaricaceae*), a poorly known Neotropical agaric. *Mycotaxon* 107: 473–481.
- Singer R. 1986. *The Agaricales in modern taxonomy*. 4th ed. Koenigstein, Koeltz Scientific Books.
- Vellinga EC. 2000. Notulae ad floram agaricinam neerlandicam – XXXVIII. *Leucoagaricus* subgenus *Sericeomyces*. *Persoonia* 17(3): 473–480.
- Vellinga EC. 2001. *Leucoagaricus*. pp. 85–108, in Noordeloos ME, Kuyper ThW, Vellinga EC (eds). *Flora agaricina neerlandica* 5. Lisse, A. A. Balkema Publishers.
- Vellinga EC. 2004. Genera in the family *Agaricaceae*: evidence from nrITS and nrLSU sequences. *Mycol. Res.* 108: 354–357.
- Vellinga EC. 2007. Lepiotaceous fungi in California, U.S.A. – 3. Pink and lilac species in *Leucoagaricus* sect. *Piloselli*. *Mycotaxon* 98: 213–224.
- Vellinga EC, Davis RM. 2007. Lepiotaceous fungi in California, U.S.A. – 1. *Leucoagaricus amanitoides* sp. nov. *Mycotaxon* 98: 197–204.
- Vizzini A, Migliozi V. 2007. *Leucocoprinus flavus*, an exotic lepiotoid taxon new to Europe. *Mycotaxon* 102: 293–306.
- Wasser SP. 1993. Tribes *Cystodermateae* Sing. and *Leucocoprineae* Sing. of the CIS and Baltic States. *Libri botanici* 9: 1–105. Eching: IHW-Verlag.

Three lichenized fungi new to Turkey and the Middle East

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Abstract -- Three species of lichenized fungi – *Arthonia calcarea*, *Buellia sequax*, and *Trapeliopsis gelatinosa* – are reported here as new to Turkey. *Buellia sequax* and *Trapeliopsis gelatinosa* are also new to the Middle East. Distribution and substrate data are presented.

Keywords -- Ardahan, Ascomycetes, biodiversity

Introduction

Studies on the lichen flora of Turkey are not as extensive as elsewhere. Recently, however, many new lichen and lichenicolous taxa have been recorded for Turkey (Aptroot & Yazici 2009, Candan & Özdemir Türk 2008, Etayo & Yazici 2009, Yazici & Aptroot 2008, Yazici et al. 2008a,b). No lichenized fungi have thus far been reported for Ardahan. The present paper contributes further information to our knowledge of the lichen flora of Turkey.

Materials and methods

The present report is based on specimens collected in the Ardahan region between 15–20 August 2008. Air-dried samples were observed and studied with a Nikon SMZ1500 stereomicroscope and a Nikon Eclipse 80i light microscope with standard identification methods for lichenized fungi (Bungartz et al. 2004, Dobson 2005, Purvis et al. 1992, Torrente & Egea 1989). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Karadeniz Technical University, Trabzon, Turkey.

Species

Arthonia calcarea (Turner ex Sm.) Ertz & Diederich

SPECIMEN EXAMINED: Ardahan, Posof, Kurşunçavuş village, near the creek, 41°31'37.76"N, 42°37'16.40"E, on calcareous rock, 1790 m, 15 August 2008, Yazıcı 2015.

Thallus crustose, saxicolous, often appearing farinose, white to pink-grey or endolithic, effigurate, usually more or less immersed in the substrate surface, the immersed hyphae with attached oil globules. Pseudotechium black lirellate or stellate ($0.4\text{--}2.3 \times 0.08\text{--}0.18$ mm), innate, delicate, simple or frequently unbranched, star-shaped, slit-like or sometimes often form piled up in heaps, roughly leafy, to (2–)3 cm in diam., brown to dark-brown; disc a persistent slit with thick \pm swollen margin. Hypothecium 10–30 μm high. Hymenium 80–100 μm tall. Ascospores ellipsoid (*calcarea*-type), 3-septate $14\text{--}20 \times 4\text{--}6$ μm . Conidia $5\text{--}8 \times 0.8\text{--}1$ μm . All spot tests negative.

Arthonia calcarea is a mediterranean lichen species, frequently found on inclined, shaded siliceous or calcareous and maritime sandstone rocks, but also on natural outcrops, walls, and man-made substrates in small urban areas.

COLLECTION SITE —Microclimatic conditions with soft and rainy winters and hot summers rule in the study area. Mean annual temperature is 6.8° C. Mean annual rainfall is 600 mm. Generally the site is a well lit, more-or-less open and has a creek. Occasionally *Corylus*, *Populus*, *Salix*, *Carpinus*, and *Picea orientalis* are also seen there.

KNOWN DISTRIBUTION: Europe (Belgium, Cyprus, England, Greece, Ireland, Norway, Slovenia, Spain, Switzerland, The Netherlands), Caucasus, North America. New to Turkey.

REMARKS—*Arthonia calcarea*, which has long been referred to *Opegrapha*, has recently been combined in *Arthonia* (Ertz et al. 2009), where we recognize it. The species resembles *Arthonia atra* and *O. saxatilis*, but *A. calcarea* is saxicolous and endolithic while *A. atra* is corticolous. The thallus of *O. saxatilis* is white or light to dark-brown, rough and scurfy while *A. calcarea* is \pm pink and immersed. In addition \pm clavate spores in *O. saxatilis* help to differentiate from *A. calcarea* which has ellipsoid spores (Dobson 2005).

Buellia sequax (Nyl.) Zahlbr.

SPECIMEN EXAMINED: Ardahan, Göle, Samandöken village, 40°51'23.06"N, 42°29'45.80"E, on siliceous rock, 2055 m, 20 August 2008, Yazıcı 2016.

Thallus crustose, thin and discontinuous, conspicuous, with poorly delimited granules or rimose to very rarely rimose-areolate, not delimited by a hypothallus; surface matt, pale-brown to greyish, smooth to slightly roughened, epruinose. Apothecia lecideine, adnate or sessile; margin soon excluded; disk black, plane, epruinose, soon convex; inner excipular hyphae, prosoplectenchymatous; hypothecium dull reddish-brown; pigmentation

concolorous with the epihymenium; hymenium hyaline, paraphyses simple to moderately branched, apically swollen, with a brown pigmented cap. Asci 8-spored, clavate, *Bacidia*-type. Ascospores 1-septate, distinctly narrowly oblong, becoming ellipsoid, with obtuse ends, not curved $10.7\text{--}12.7 \times 3.8\text{--}5.4$ μm , one septate; thin perispore (0.1–0.2 μm), narrow thick proper spore wall (0.3–0.5 μm). Pycnidia rare, conidia simple, bacilliform, $2.0\text{--}4.0 \times 1.0\text{--}1.5$ μm . All spot test negative, but very rarely K+ orange.

Buellia sequax grows on a large variety of siliceous rocks from coastal up to subalpine localities.

COLLECTION SITE – The climate is continental with hot dry summers and cold snowy winters. The mean annual rainfall is 500 mm and a mean annual temperature is 5°C. The site is well lit, open area, gently \pm sloped terrain, sunny and covered with grass and rocks, and lies among agricultural areas and extensive plains.

KNOWN DISTRIBUTION: Europe (Austria, England, Ireland, Italy, Spain, Switzerland, Greece: Kalimnos and parts of Kos Islands), Morocco, China: Hongkong, Mexico, North America, Pacific Island: Guadalupe, Venezuela. New to Turkey and the Middle East.

REMARKS—It is difficult to separate *Buellia sequax* with well-developed thallus from *B. prospersa*. *Buellia sequax* has bacilliform conidia while *B. prospersa* has filiform. Young ascospores of *B. sequax* are typically narrowly oblong and not ornamented while *B. prospersa* typically have a thickened medium septum. Only overmature and often disintegrating ascospores of *B. sequax* show a weak ornamentation whereas a microrugulate ornamentation usually develops in *B. prospersa*. Furthermore, *B. prospersa* is more or less chasmolithic instead of saxicolous.

Trapeliopsis gelatinosa (Flörke) Coppins & P. James

SPECIMEN EXAMINED: Ardahan, Posof, Kurşunçavuş village, near the creek, 41°31'37.76"N, 42°37'16.40"E, on calcareous rock, 1790 m, 15 August 2008, Yazici 2020.

Thallus thin, minutely granular crust, and membranous, effuse, dark green-brown to green-grey, P–, K–, KC–, C–, with pale green soralia, at first 0.2–0.7 mm diam., but often becoming very conspicuous, irregular and confluent. The small soralia contrasting in colour with the darker thallus surface, occasionally no soralia are present. Photobiont trebouxoid. Apothecia 0.2–1(–1.6) mm diam., adpressed; exciple excluded or as a thin, pale rim not exceeding the level of the disc, dark green-grey to grey-black; epithecium green, K+ brown. Ascospores $8\text{--}14 \times 4.5\text{--}6$ μm .

Trapeliopsis gelatinosa grows mainly on shaded, damp, peaty banks, humus-rich soil, cuttings with overhanging herbs, or small shrubs, sometimes corticolous on *Tilia*; rather local, especially in upland districts.

COLLECTION SITE – See *Arthonia calcarea* above for climatic conditions. In addition especially *Picea orientalis* is predominantly seen there.

KNOWN DISTRIBUTION: Europe (Belgium, Czech Republic, Croatia, England, France, Germany, Ireland, Luxembourg, Norway, Scotland: Arran Island, Spain), Australia, Canada: Central Siberia, Michigan, North America. New to Turkey and the Middle East.

REMARKS – *Trapeliopsis gelatinosa* resembles *T. aeneofusca*, but apothecia in *T. aeneofusca* are pale to reddish brown and the epithecium is \pm colourless to reddish brown. In addition, the epithecium in *T. gelatinosa* is K+ brown, but in *T. aeneofusca* K–.

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Literature cited

- Aptroot A, Yazici K. 2009: *Opegrapha pauciexcipulata*, a new corticolous lichen from Turkey. Mycotaxon 108: 155–158.
- Bungartz F, Nash III TH, Ryan BD. 2004: Morphology and anatomy of chasmolithic versus epilithic growth: a taxonomic revision of conspicuous saxicolous *Buellia* species from the Sonoran Desert Region generally ascribed to the “*Buellia punctata*” group. Can. J. Bot. 82: 540–562.
- Candan M, Özdemir Türk A. 2008: Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). Mycotaxon 105: 19–22.
- Ertz D, Miadlikowska J, Lutzoni F, Dessenin S, Raspé O, Vigneron N, Hofstetter V, Diederich P. 2009. Towards a new classification of the *Arthoniales* (*Ascomycota*) based on a three-gene phylogeny focussing on the genus *Opegrapha*. Mycol. Res. 113: 141–152.
- Dobson FS. 2005: An Illustrated Guide to the British and Irish Species. The Richmond Publishing Co. Ltd., England.
- Etayo J, Yazici K. 2009: *Microsphaeropsis caloplacae* sp. nov. on *Caloplaca persica* in Turkey. Mycotaxon 107: 297–302.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992: The lichen flora of Great Britain and Ireland. Natural History Museum Publications & The British Lichen Society, London.
- Torrente P, Egea JM. 1989: La familia *Opegraphaceae* en el área Mediterránea de la Península Ibérica y Norte de África. Bibl. Lichenol. 32: 1–282.
- Yazici K, Aptroot A. 2008: Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. Mycotaxon 105: 95–104.
- Yazici K, Aptroot A, Etayo J, Aslan A, Guttova A. 2008a: Lichens from the Batman, Mardin, Osmaniye, and Sivas regions of Turkey. Mycotaxon 103: 141–144.
- Yazici K, Elix JA, Aslan A. 2008b: *Xanthoparmelia pustulosa* (*Parmeliaceae*), a lichen new to Asia. Mycotaxon 104: 35–37.

New records in the *Tubeufiaceae* from Andean Patagonian forests of Argentina

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Abstract — *Tubeufiaceae* (Pleosporales, Ascomycota) occurring on native trees from the Andean Patagonian forests in Argentina are described and illustrated. *Acanthostigma minutum* and *Tubeufia cerea* with its anamorphic state are reported from South America for the first time on *Nothofagus dombeyi* and *N. antarctica*, respectively. Both species were up to now only known from the Northern Hemisphere.

Key words — ascomycetes, *Helicosporium*, *Nothofagaceae*

Introduction

Barr (1979) erected the family *Tubeufiaceae* to accommodate several genera of *Pleosporales* that are saprobic on wood, hypersaprobic or hyperparasitic on other fungi, or parasitic on scale insects. The ascomata are small, pallid yellowish to brownish, globose, conic, ellipsoid or cylindrical. She included six genera in the family: the type genus *Tubeufia*, *Letendraea* Sacc., *Melioliphila* Speg., *Podonectria* Petch, *Rebentischia* P. Karst., and *Thaxteriella* Petr. Later, Barr (1980) added five more genera — *Allonecte* Syd., *Boerlagiomyces* Butzin, *Byssocallis* Syd., *Paranectriella* (Henn. ex Sacc. & D. Sacc.) Höhn., and *Puttemansia* Henn. — and synonymized *Thaxteriella* with *Tubeufia*.

The classification of the *Tubeufiaceae*, mainly based on morphology, has been controversial. Eriksson (2005) placed this family as “*Dothideomycetes* et *Chaetothyriomycetes* incertae sedis”. Based on sequence analyses Kodsueb et al. (2006) considered the *Tubeufiaceae* a distinct monophyletic family that clusters within the *Pleosporales* as originally proposed by Barr (1980) and excluded *Boerlagiomyces* and *Letendraea* as phylogenetically unrelated. At the same time Tsui & Berbee (2006) arrived at similar results analyzing molecular data of several *Tubeufia* taxa and helicosporous fungi that are considered anamorphic

states of *Acanthostigma* and *Tubeufia*. They indicated that many *Tubeufia* spp. and most species of *Helicoma*, *Helicomycetes*, and *Helicosporium* lay within a strongly supported monophyletic lineage, the *Tubeufiaceae* sensu stricto.

Most species of *Tubeufiaceae* are considered tropical, but there are species that occur primarily in temperate areas (Hughes 1978; Rossman 1979, 1987; Samuels et al. 1978). Additional austral records are known in Argentina, Brazil, Chile, and Paraguay, i.e. four *Acanthostigma* species described by Spegazzini (1884, 1887, 1899, 1909), *Rebentischia costi* in Brazil (Batista et al. 1963), and *Rebentischia massalongoi* recently recorded in Argentina (Bianchinotti & Sánchez 2009).

Rebentischia is an accepted member of *Tubeufiaceae* (Kodsueb et al. 2006) but the position of *Acanthostigma* is doubtful. De Notaris established the genus in 1863 with *A. perpusillum* as type. From the beginning its taxonomic status was confused, with the genus referred first to the *Sphaeriaceae* by Saccardo (1883), to the *Trichosphaeriaceae* by Ellis & Everhart (1892), and then synonymized with *Tubeufia* by Arx & Müller (1975). Barr (1980) regarded *Acanthostigma* as a section in *Tubeufia* but later (Barr 1990, 1993) returned it to the *Trichosphaeriaceae* based on its unitunicate asci. Crane et al. (1998) established another genus in the *Tubeufiaceae*, *Acanthostigmia* Höhn. More recently, Réblová & Barr (2000) examined the type material of *Acanthostigma* and confirmed its position in *Tubeufiaceae*, citing *Acanthostigmia* as a synonym. Tsui et al. (2006) found that *A. perpusillum* clusters with *Tubeufia cerea*, and they suggested that *Tubeufia* should be synonymized under *Acanthostigma*.

We have re-examined the specimens representing *Acanthostigma* described by Spegazzini that have not been included in former revisions of the genus. Also, we describe and illustrate other representatives of the *Tubeufiaceae* s.l. collected on native trees from the Andean Patagonian forests. *Acanthostigma* and *Tubeufia* are recorded for the first time in Argentina, with *Acanthostigma minutum* and *Tubeufia cerea* reported for the first time in South America. These new records expand the geographical distribution of the family to the most austral point.

Materials and methods

The samples were collected in forests of Los Alerces National Park (Chubut) and Lanín National Park (Neuquén) located in the southern Andes of Patagonia (Argentina). The vegetation is composed mostly of native *Nothofagus* species together with some species of *Cupressaceae*, *Proteaceae*, ferns and mosses. The climate is temperate to cold with high humidity. Leaves, small branches and bark showing fungal growth when observed with a field magnifying glass were placed in paper bags and transported to the laboratory. The samples were dried at room temperature and deposited at Bahía Blanca Biology Herbarium

(BBB). For microscopic examinations sections were hand-made and mounted in water or 5% KOH with phloxine. At least ten measurements were taken for each structure and all were made in tap water. Calcofluor 1% was used for the examinations made under the fluorescence microscope. The LPS and NYBG Herbaria provided type material. Herbarium abbreviations follow Holmgren et al. (1990). The term " x_{av} " represents the average dimension.

Results and discussion

Acanthostigma De Not., Sfer. Ital., Cent. I, Fasc. 2: 85. 1863.

TYPE SPECIES: *A. perpusillum* De Not.

Acanthostigma minutum (Fuckel) Sacc., Syll. Fung. 2: 209. 1883.

FIGS. 1–7

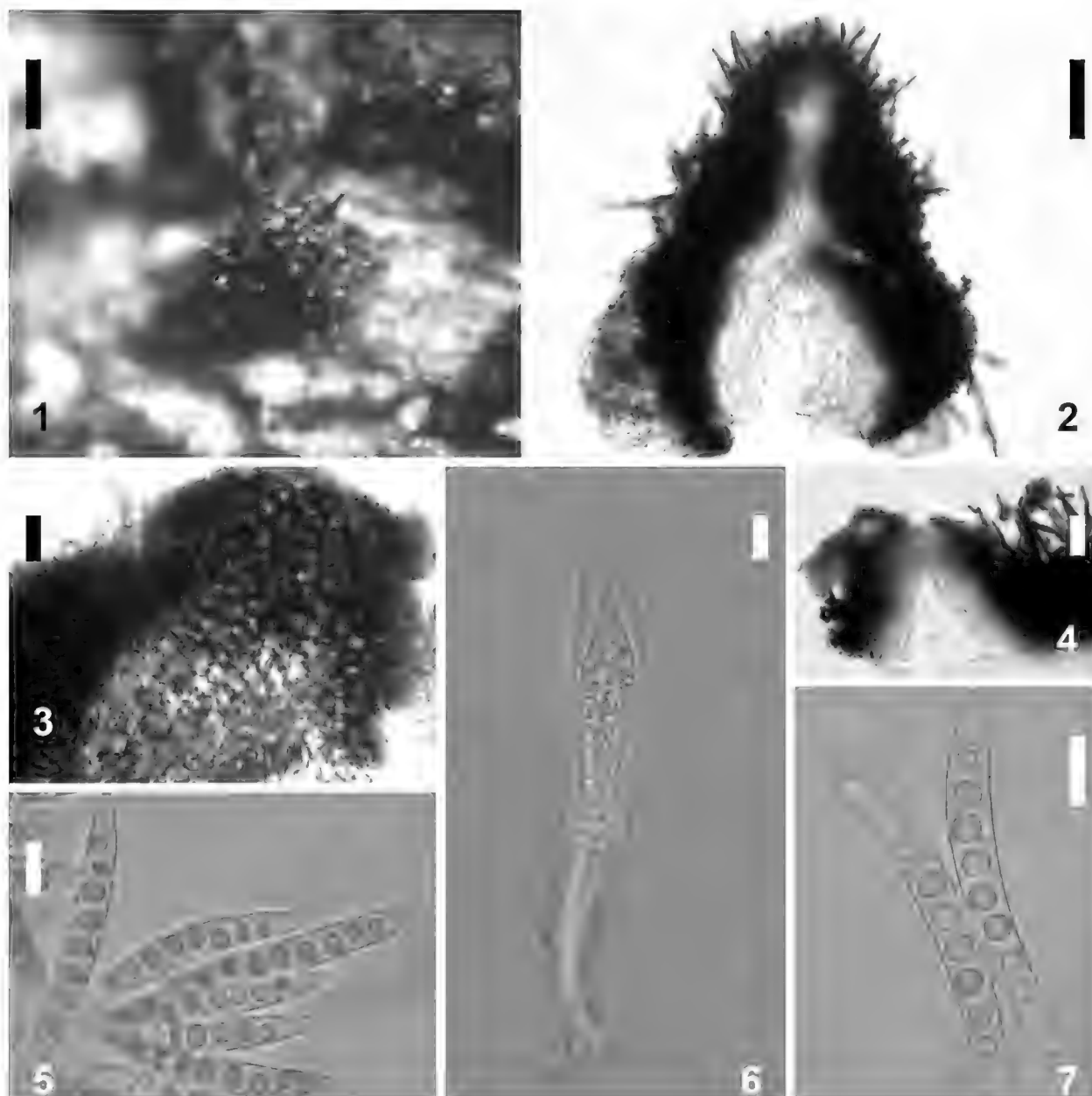
ASCOMATA superficial to semi-immersed under periderm, globose to subglobose, dark brown to black when dried, $(95-110-300(-350) \times 100-300(-330) \mu\text{m}$; ostiole papillate, $61-112.5 \times 35.7-47.5 \mu\text{m}$; surface covered with setae, straight or curved, most densely distributed on upper half, 0–1 septate, dark brown, $46-130 \mu\text{m}$ long ($x_{av} = 79 \mu\text{m}$), $3-8.2 \mu\text{m}$ wide at base ($x_{av} = 6 \mu\text{m}$), $1-3.8 \mu\text{m}$ wide at apex ($x_{av} = 1.9 \mu\text{m}$). PERIDIUM of *textura angularis*, two-layered in longitudinal section, outer layer composed of 3–5 rows of thick-walled, dark brown cells, inner layer composed of 2–4 rows of light brown cells, $18-55 \mu\text{m}$ thick ($x_{av} = 35 \mu\text{m}$). PSEUDOPARAPHYSES cellular ramified, anastomosed, septate, hyaline, $1-3 \mu\text{m}$ thick. PERIPHYSOIDES cellular ramified, septate, hyaline, ca. $2.5 \mu\text{m}$ thick. ASCI bitunicate, cylindrical to clavate, $80-150 \times 12-50 \mu\text{m}$ ($x_{av} = 116 \times 22 \mu\text{m}$), 8-spored. ASCOSPORES elongate fusiform, tapering to ends and rounded, symmetric, straight or slightly curved, $(7-) 9 (-12)$ septate, not constricted or slightly constricted at septa, hyaline, smooth, $35-68(-75) \times 5-8 \mu\text{m}$ ($x_{av} = 50 \times 6.8 \mu\text{m}$). ANAMORPH — *Helicomyces* sp. (not seen).

DISTRIBUTION — America (Argentina, Canada, USA); Asia (China, Taiwan); Europe (France, Germany, Switzerland).

ECOLOGY — on decaying wood of deciduous trees and woody, dicotyledonous shrubs and on old ascomata of other ascomycetes. Recorded on *Fagus sylvatica* L., *Gaultheria shallon* Pursh, *Nothofagus dombeyi* (Mirb.) Oerst., *Populus* sp., and *Quercus* sp.

MATERIAL EXAMINED — ARGENTINA: Neuquén, Parque Nacional Lanín, on the way to Hui Hui lake, on old xylariaceous stromata on bark of *Nothofagus dombeyi*, 17. V. 2007, leg. MV Bianchinotti and RM Sánchez 579 (BBB), Paso del Cordoba, on bark of *N. dombeyi*, 18. I. 2009, leg. MV Bianchinotti and RM Sánchez 776 and 781 (BBB). USA: Connecticut, 1 mi south of Canaan, on decayed wood associated with *Hemitrichia clavata*, 2. XI. 1959, CT Rogerson, (as *Acanthostigma decastylum*, NY).

COMMENTS — *Acanthostigma minutum* is recorded for the first time in South America. It was found without its anamorph growing on old xylariaceous



FIGURES 1–7. *Acanthostigma minutum* (from MVB-RS 579, 776 & 781, deposited in BBB). 1. Ascoma on bark of *Nothofagus dombeyi*. 2. Longitudinal section. 3. Peridium. 4. Section of papilla. 5, 7. Ascospores. 6. Ascus. Bars: 1 = 100 μm . 2 = 50 μm . 4 = 20 μm . 3, 5–7 = 10 μm

stromata on *Nothofagus dombeyi* logs. We compared our specimens with a collection from the USA authenticated by Réblová & Barr (2000), which differs in having ascospores with more septa (10–14). This is the first record of the genus in Argentina.

Excluded and doubtful species

Acanthostigma dimerosporioides Speg., Anal. Mus. Nac. Bs. As. 6: 277. 1898.

FIGS. 8–9

ASCOMATA superficial, globose, setose, dark brown, 155–158 μm diam, ostiole circular, 28 μm diam. SETAE septate, brown, 50–250 \times 4–5 μm (fide Spegazzini

1898). ASCI bitunicate. PSEUDOPARAPHYSES not seen. ASCOSPORES fusiform, 3-septate, dark brown, smooth, $18.5\text{--}20 \times 5 \mu\text{m}$.

MATERIAL EXAMINED — ARGENTINA, La Plata, on *Gnaphalium purpureum*, III 1899, leg. CL Spegazzini (LPS 2667!).

COMMENTS — The 3-septate, dark brown ascospores exclude this material from *Acanthostigma*. We think the specimen probably belongs to *Herpotrichiellaceae*.

Acanthostigma gnaphaliorum Speg., Anal. Mus. Nac. Bs. As. 19: 375. 1909.

FIGS. 10–11

Ascomata superficial, globose, setose, dark brown, $169\text{--}170 \mu\text{m}$ diam, ostiole circular, $35 \mu\text{m}$ diam. SETAE 2–8 septate, brown to pale brown, $95\text{--}145 \mu\text{m}$ long and $3.5\text{--}5 \mu\text{m}$ wide at base. ASCI unitunicate, without any visible apical apparatus, $50\text{--}60 \times 8 \mu\text{m}$. PSEUDOPARAPHYSES not seen. ASCOSPORES fusiform, with one inner cell slightly broader, 3-septate, pale brown, smooth.

MATERIAL EXAMINED — ARGENTINA, La Plata, Ensenada, on *Gnaphalium purpureum*, 28. XI. 1906, leg. CL Spegazzini (LPS 2391!).

COMMENTS — Only immature ascospores still in the asci were seen. Spegazzini described it as aparaphysate. This species does not belong to the *Tubeufiaceae* because of the combination of unitunicate asci and 3-septate, pale brown ascospores. It resembles members of the *Chaetosphaeriaceae*.

Acanthostigma imperspicuum Speg., Bol. Acad. Nac. Ci. Córdoba 11: 46. 1887.

FIGS. 12–16

ASCOMATA superficial, globose, setose, reddish dark brown, $189\text{--}202 \mu\text{m}$ diam. SETAE dark brown, $38 \mu\text{m}$ long. ASCI not seen. ASCOSPORES fusiform, with one inner cell slightly broader, 3-septate, pale brown, smooth, $13\text{--}16 \times 4\text{--}5 \mu\text{m}$.

MATERIAL EXAMINED — CHILE, Patagonia, Cabo Negro, on *Fagus antarcticum* [= *Nothofagus antarctica*], VI 1886, leg. CL Spegazzini (LPS 87!).

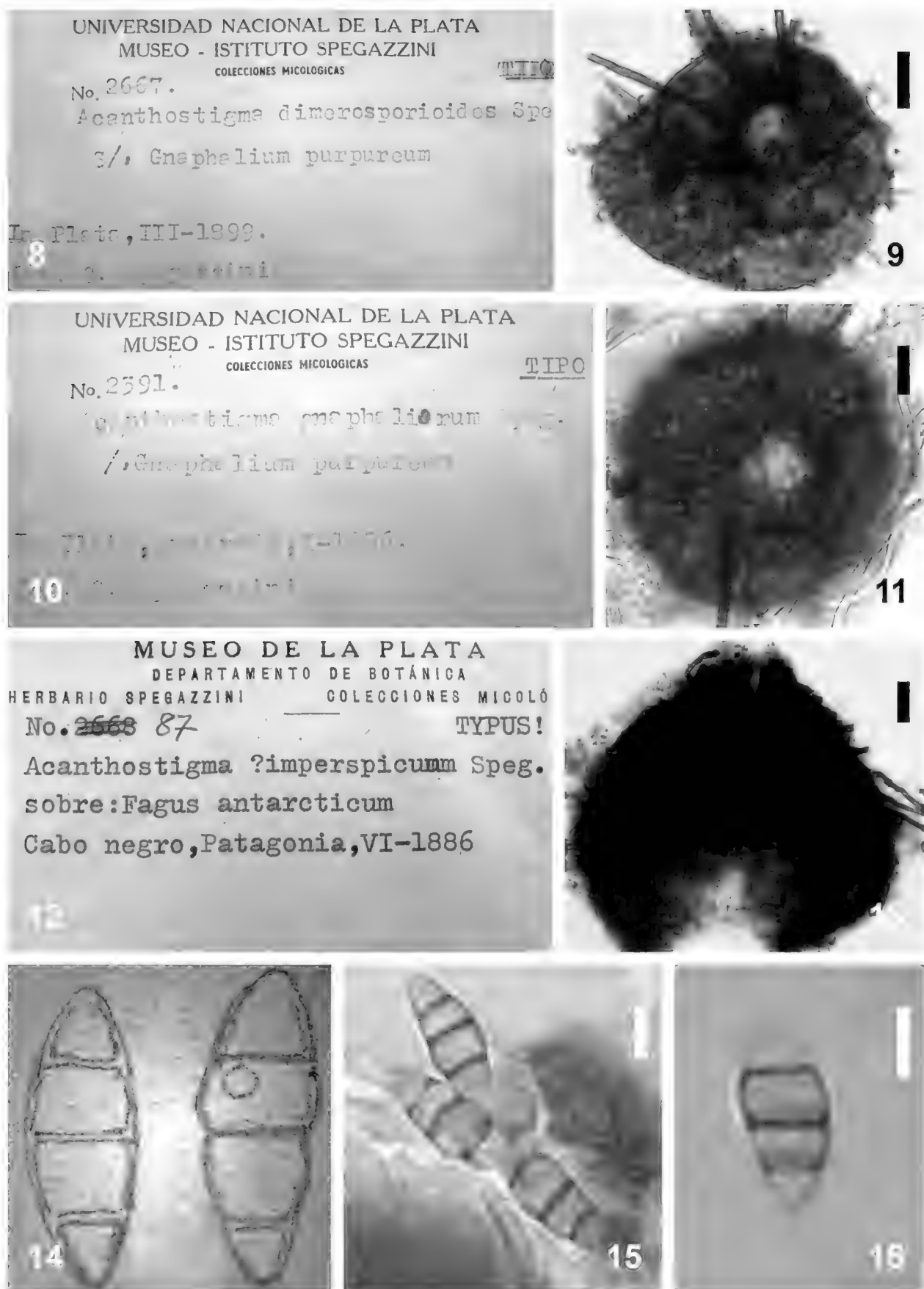
COMMENTS — The material is in poor condition and has no asci; however, Spegazzini illustrated the asci as unitunicate. Because of the combination of characters, it probably belongs in the *Chaetosphaeriaceae*.

Acanthostigma guaraniticum Speg., Anal. Soc. Ci. Argent. 18(6): 286. 1884.

FIGS. 17–20

MATERIAL EXAMINED — PARAGUAY, Caá-Guazú, on *Eugenia* sp., Leg. Balanza 3452, I 1882, det. CL Spegazzini (LPS 2664!).

COMMENTS — This material is very scarce and consists of a single, small leaf of *Eugenia* sp. We could not find any ascomata. Brown conidiophores were observed, but no conidia were found. According to Spegazzini's drawings on the type envelope (available also in Arambarri et al. 2008), this species resembles



FIGURES 8–16. Spegazzini's herbarium material (from LPS). 8, 10 and 12. Envelopes of the types. 8–9. *Acanthostigma dimerosporioides* (LPS 2667!). 9. Ascoma top view. 10–11. *A. gnaphaliorum* (LPS 2391!). 11. Ascoma top view. 12–16. *A. imperspicuum* (LPS 87!). 13. Ascoma side view. 14. Drawing of ascospores done by Spegazzini on type envelope. 15–16. Ascospores (LPS 87!).

Bars: 9, 11, 13 = 20 µm. 15–16 = 3 µm.

MUSEO DE LA PLATA
DEPARTAMENTO DE BOTANICA
HERBARIO SPEGAZZINI COLECCIONES MICOLÓGICAS
No. 2664 TYPUS!
Acanthostigma guaraniticum Speg.
sobre: *Eugenia* sp.
Caa-guazú, Paraguay, I-1882
Leg.: Balanza No. 3452

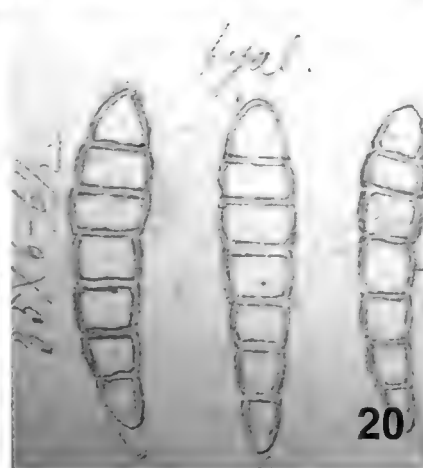


17

18



19



20

FIGURES 17–20. *Acanthostigma guaraniticum* (from LPS 2664!). 17. Envelope of the type. 18–20. Original illustrations from type envelope. 18. Superficial and setose ascoma. 19. Summary of all the structures and tissues. 20. Ascospores.

a true *Acanthostigma*. However, Spegazzini described the asci as unitunicate (Spegazzini 1884) so, until authentic material is located, this should be treated as a species dubia.

Tubeufia Penz. & Sacc., Malpighia 11: 517. 1897.

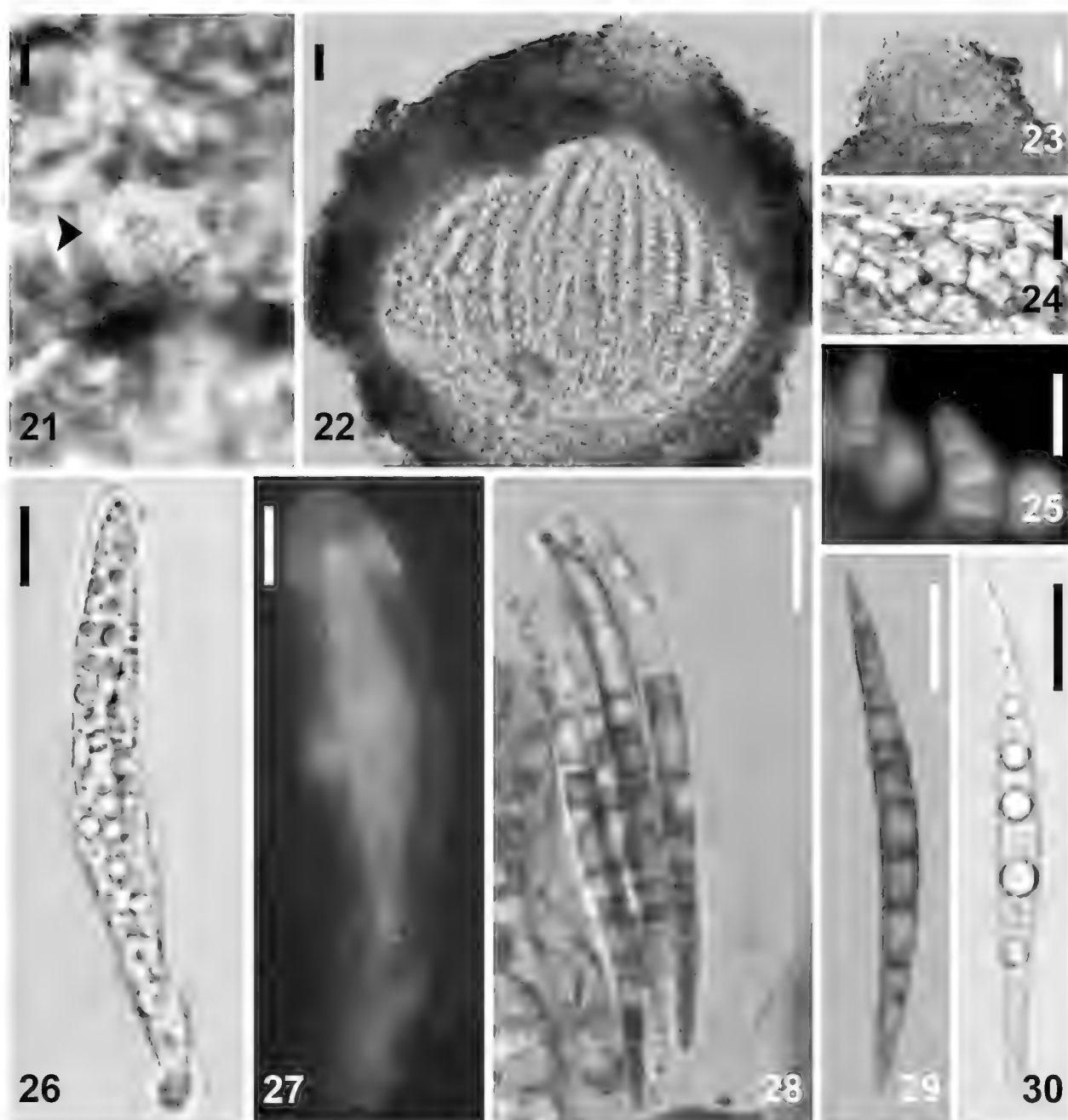
TYPE SPECIES: *T. javanica* Penz. & Sacc. [= *T. paludosa* (P. Crouan & H. Crouan) Rossman].

Tubeufia cerea (Berk. & M.A. Curtis) Höhn., Sitzungsber. Akad. Wiss.,

Math.-Naturwiss. Kl., Abt. 1, 128: 562. 1919.

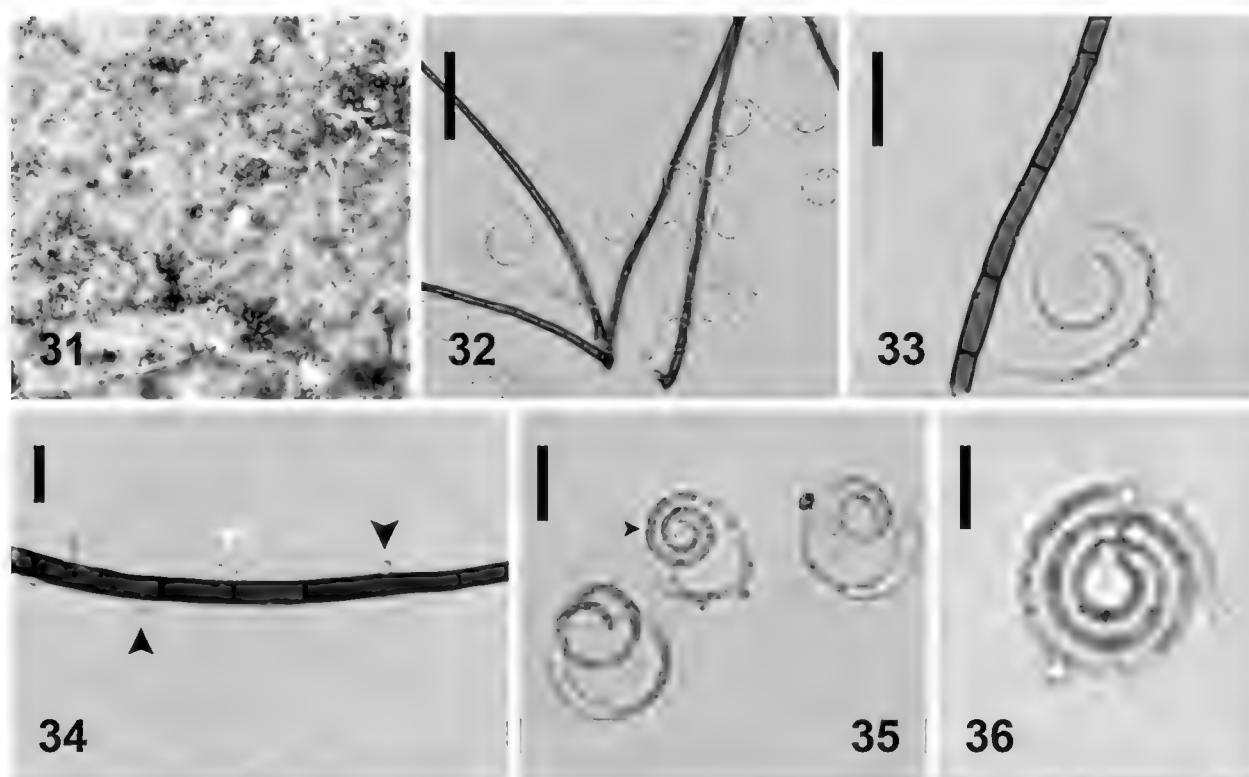
FIGS. 21–36

ASCOMATA globose or collabent when dried, bright yellow becoming yellowish brown towards base, a little darker in depression around the papilla, 170–225 × 80–215 µm (x_{av} = 200 × 130 µm); papilla 30–50 × 55–100 µm (x_{av} = 40 × 77.5 µm); ostiole circular, 30–40.8 µm (x_{av} = 36 µm); surface pulverulent with protruding conical cells, sometimes curved, with 1–3 septa, yellow, 5–8 × 4–5 µm. PERIDIUM 20–50 µm thick (x_{av} = 36 µm), forming *textura angularis*, cells 5–10 × 3–8 µm (x_{av} = 7.6 × 5 µm). ASCI bitunicate, cylindrical to claviform, 76–87 × 10–13 µm (x_{av} = 81.4 × 11.4 µm). PSEUDOPARAPHYSES narrow, ramified, parallel or somewhat interwoven, septate, 1–2 µm thick. ASCOSPORES elongate fusiform, often curved, apices acute, 6–11 septate, not constricted at septa, hyaline or slightly yellowish, smooth, 38.8–58 × 3–6 µm (x_{av} = 48.7 × 4 µm).



FIGURES 21–30. *Tubeufia cerea* (from MVB-RS 564, deposited in BBB). 21. Ascoma (arrow head) on bark of *Nothofagus antarctica*. 22. Longitudinal section. 23. Papilla. 24. Peridium. 25. Protruding conical cells of the ascomal wall showing the septa using fluorescence microscopy. 26. Ascus 8-spored (in water). 27. Ascus viewed with fluorescence microscopy. 28–30. Ascospores (28–29 in phloxine, 30 in water). Bars: 21 = 50 μm , 23 = 20 μm , 22, 26–30 = 10 μm , 24–25 = 5 μm .

ANAMORPH — *Helicosporium virescens* (Pers.) Sivan. COLONIES effuse, forming a loose, cottony layer, yellow to greenish yellow. MYCELIUM scarcely ramified, hyaline to pale brown, 2–10 μm wide. CONIDIOPHORES erect, unbranched, dark brown basally, pale brown to hyaline towards the setiform sterile apex, 61–210 μm long, 2.5–10 μm wide at base, 2–2.5 μm wide at apex. CONIDIOGENOUS CELLS integrated, mono or polyblastic, 7–21 \times 2–3 μm . CONIDIA cochleated, coiled 2–3 times, multiseptate, hyaline, smooth, coils 10–21 μm diam (x_{av} = 16.6 μm), cells 1.5–2 μm wide.



FIGURES 31–36. *Tubeufia cerea* anamorph: *Helicosporium virescens* (from MVB–RS 564, deposited in BBB). 31. Colony on *Nothofagus antarctica*. 32. Conidiophores and conidia. 33. Conidium attached to conidiophore. 34. Conidiophore showing two monoblastic conidiogenous denticles (black arrows) and a polyblastic denticle (white arrow). 35. Conidia with septa (arrow points to a septum). 36. Conidia coiled three times. Bars: 32 = 20 μm . 33–35 = 10 μm . 36 = 5 μm .

DISTRIBUTION — Africa (Congo); Asia (USSR, India); America (Argentina, Canada, Guyana, Puerto Rico, USA); Europe (Austria, Belgium, Finland, France, Germany, Netherlands, Poland, Portugal, Sweden, UK).

ECOLOGY — On wood and bark lying on the ground, on herbaceous substrates, and on old ascomata or mycelium of other ascomycetes.

MATERIAL EXAMINED — ARGENTINA, Neuquén, Parque Nacional Lanín, RN 234 near Villa Traful access route, on log of *Nothofagus antarctica* (G. Forst) Oerst., 16. V. 2007, leg. MV Bianchinotti and RM Sánchez 564 (BBB).

COMMENTS — The genus *Tubeufia* was erected in 1897 by Penzig and Saccardo to accommodate three species from Java (i.e., *T. javanica*, *T. coronata*, *T. anceps*) characterized by white, cream-pink to brownish, vertically oblong to ovoid ascomata and cylindrical, fusiform to vermiform, multiseptate ascospores.

This is the first record of *Tubeufia* in Argentina and the first time that *Tubeufia cerea* is recorded in South America. Our material differs from that described by Munk (1957) in having larger ascospores ($36\text{--}48 \times 2.5\text{--}3.5 \mu\text{m}$). *Tubeufia cerea* is widely distributed in temperate areas in the Northern Hemisphere, with a few records from the tropics (Cannon 1999). This is the first report of this species in the subpolar zone.

Other species of *Tubeufia* previously recorded in South America are *T. albo-ostiolata* Rossman in Venezuela, *T. amazonensis* Samuels et al. in Brazil, and *T. aurantiella* (Penz. & Sacc.) Rossman, *T. cylindrothecia* (Seaver) Höhn., *T. helicoma* (W. Phillips & Plowr.) Piroz., *T. palmarum* (Torrend) Samuels et al., and *T. paludosa* in Brazil and Venezuela (Rossman 1987, Samuels et al. 1978).

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Literature cited

- Arambarri AM, Minter TJ, Cabello MN, Minter DW. 2008. Spegazzini – Dibujos de Hongos, una Biblioteca Digitalizada. [www.cybertruffle.org.uk/spegazzini, website accessed: 10.10.2008]
- Arx JA, Müller E. 1975. A re-evaluation of the bitunicate *Ascomycetes* with keys to families and genera. *Stud. Mycol.* 9: 1–159.
- Barr ME. 1979. A classification of *Loculoascomycetes*. *Mycologia* 71: 935–957.
- Barr ME. 1980. On the family *Tubeufiaceae* (*Pleosporales*). *Mycotaxon* 12: 137–167.
- Barr ME. 1990. Prodromus to nonlichenized, pyrenomycetous members of class *Hymenoascomycetes*. *Mycotaxon* 39: 43–184.
- Barr ME. 1993. Redisposition of some taxa described by J.B. Ellis. *Mycotaxon* 46: 45–76.
- Batista AC, Bezerra JL. 1963. Alguns *Ascomycetes* Hialofragmos de Significação Fitopatológica. *Publ. Univ. Recife Inst. Micol.* 385: 6–9.
- Bianchinotti MV, Sánchez RM. 2009. Micromycetes on *Austrocedrus chilensis*. First record of *Rebentischia* from Argentina. *Mycotaxon* 107: 449–454.
- Cannon PF. 1999. *Tubeufia cerea*. I.M.I. Description of Fungi and Bacteria 1409: 1–2.
- Crane JL, Shearer CA, Barr ME. 1998. A revision of *Boerlagiomyces* with notes and a key to the saprobic genera of *Tubeufiaceae*. *Can. J. Bot.* 76: 602–612.
- Ellis JB, Everhart BM. 1892. The North American *Pyrenomycetes*. Ellis & Everhart, Newfield, New Jersey. (USA). 793 p.
- Eriksson OE. 2005. Outline of *Ascomycota* – 2005. *Myconet* 11:1–113.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum: Part I: Herbaria of the World. 8th ed. Bronx, New York Botanical Garden.
- Hughes SJ. 1978. New Zealand fungi 25. Miscellaneous species. *New Zeal. J. Bot.* 16: 311–370.
- Kodsueb R, Jeewon R, Vijaykrishna D, McKenzie EHC, Lumyong P, Lumyong S, Hyde KD. 2006. Systematic revision of *Tubeufiaceae* based on morphological and molecular data. *Fungal Divers.* 21: 105–130.
- Munk A. 1957. Danish pyrenomycetes. A preliminary flora. *Dansk Bot Ark* 17: 1–478.
- Réblová M, Barr ME. 2000. The genus *Acanthostigma* (*Tubeufiaceae*, *Pleosporales*). *Sydowia* 52: 258–285.

- Rossmann AY. 1979. *Calonectria* and its type species, *C. daldiniana*, a later synonym of *C. pyrochroa*. Mycotaxon 8: 321–328.
- Rossmann AY. 1987. The *Tubeufiaceae* and similar Loculoascomycetes. Mycol. Pap. 157: 1–71.
- Saccardo PA. 1883. Pyrenomycetae. Sylloge Fungorum, Padua, (Italy) 2. 813p.
- Samuels GJ, Rossmann AY, Müller E. 1978. Life-history studies of Brazilian *Ascomycetes* 6. Sydowia 31: 1–6.
- Spegazzini CL. 1884. Fungi Guaranitici. Pugillus I. Anal. Soc. Ci. Argent. 18(6): 263–286.
- Spegazzini CL. 1887. Fungi Patagonici. Bol. Acad. Nac. Ci. Córdoba 11(1): 5–64.
- Spegazzini CL. 1898. Fungi Argentini novi v. critici. Anal. Mus. Nac. Bs. As. 6: 81–365.
- Spegazzini CL. 1909. Mycetes Argentinenses (Series IV). Anal. Mus. Nac. Bs. As. 19(12): 257–458.
- Tsui CKM, Berbee ML. 2006. Phylogenetic relationships and convergence of helicosporous fungi inferred from ribosomal DNA sequences. Mol. Phyl. Evol. 39: 587–597.
- Tsui CKM, Sivichai S, Berbee ML. 2006. Molecular systematics of *Helicoma*, *Helicomycetes* and *Helicosporium* and their teleomorphs inferred from rDNA sequences. Mycologia 98: 94–104.

***Phylloporus colligatus* sp. nov., a new gilled bolete from Guyana**

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Abstract—*Phylloporus colligatus* from Guyana is described for the first time. The species occurs in forests dominated by *Dicymbe* trees. The taxon is unique for *Phylloporus* due to its rare to infrequent clamp connections at the basal septa of basidia and on hymenophoral trama hyphae, and hyaline fusoid hymenial cystidia.

Key words—*Boletaceae*, *Caesalpinioideae*, neotropics, taxonomy

Introduction

In Guyana, forests with ectomycorrhizal (EM) *Dicymbe* spp. (*Fabaceae* subfam. *Caesalpinioideae*, tribe *Amherstieae*) contain taxa of several genera of *Boletaceae* sensu lato (Henkel 1999, Henkel et al. 2002, Fulgenzi et al. 2007, 2008, 2010; Mayor et al. 2008). This bolete assemblage includes the lamellate *Phylloporus* Qué!., which comprises 70 species worldwide, largely with tropical distributions (Corner 1970, Halling 1989, Halling et al. 1999, Montoya & Bandala 1991, Singer & Gómez 1984, Singer et al. 1990). Here we describe a new species of *Phylloporus* from Guyana that is unique because it has clamp connections at the base of some of the basidia and at the septa of a few hymenophoral trama hyphae and hyaline fusoid hymenial cystidia.

Materials and methods

Collections were made during the May–July rainy season of 2001 from the Upper Potaro River Basin, within a 5 km radius of a permanent base camp at 5° 18' 04.8" N; 59° 54' 40.4" W; elevation 710 m. This collecting site is located in an undulating valley

approximately 20 km east of Mt. Ayanganna (2200 m), and is densely forested with a mosaic of primary *Dicymbe*-dominated and mixed forests of the *Eschweilera-Licania* association (Henkel 2003).

Macromorphological features were described fresh in the field. Colors were described subjectively and coded according to Kornerup & Wanscher (1978), with color plates noted in parentheses (e.g., 4A7). Macrochemical tests were performed according to the methods of Singer (1986). Fungi were field-dried with silica gel.

Microscopic sections were mounted in 5% KOH solution and Melzer's reagent after being rehydrated with ethanol and then in water. The sections were observed with an Olympus BH-2 light microscope. Mean Q is the average of length/width derived from each basidiospore measured. To test for the fleeting amyloid reaction, a small piece of a lamella was mounted in Melzer's reagent and carefully compressed between the slide and cover slip (Watling & Gregory 1991, Ladurner & Simonini 2003). A positive reaction is visible to the naked eye as a color change of the tissue to blue when the slide is placed on white paper. Line drawings were made with the aid of a drawing tube. Specimens were deposited in the following herbaria: BRG and HSU (Holmgren et al. 1990). The microscopic descriptions were generated from a Delta database (Dallwitz 1980, Dallwitz et al. 1993 onwards).

Taxonomy

Phylloporus colligatus M.A. Neves & T.W. Henkel, **sp. nov.**

FIGS 1–2

MYCOBANK MB 515394

Pileo plano-convexo, rubro-brunneo vel aureo-brunneo, sicco, subtomentoso, 10–17 mm lato, cum NH₄ caerulescenti mox brunneo. Contextus flavus, immutatus. Lamellis decurrentis vel adnaxis, flavis, ubi contusi atroflavis. Stipes aequalus, aureus. Contextus albidus vel flavus. Mycelio basali flavo. Sporis 8.4–9.8 × 3.5–4.2 μm. Hyphis fibulatis.

TYPE: GUYANA, Region 8 (Potaro-Siparuni), Pakaraima Mountains, Upper Potaro River Basin, 15 km east of Ayanganna Mountain, 3 km southwest of base camp, 5 May 2001, Henkel 8026 (BRG, **holotype**; HSU, **isotype**).

ETYMOLOGY: *colligatus*, from the Latin for “connected”, due to the presence of clamp connections.

KEY CHARACTERS — *Phylloporus colligatus* is distinguished microscopically by the presence of clamp connections at the base of some of the basidia and the septa of a few hymenophoral trama hyphae, and hyaline fusoid hymenial cystidia. This taxon can be easily recognized as a member of *Phylloporus* because of the following: a lamellate, yellow hymenophore; presence of hymenial cystidia; and the pale yellow color of the spores when mounted in KOH (Singer 1986). Its combination of macro- and microscopic features is unique among described species of *Phylloporus*.

MACROCHARACTERS — **PILEUS** 10–17 mm broad, 5–9 mm high, plano-convex, dry, surface even, finely matted subtomentose throughout; reddish orange-brown (7E8–8E8); margin entire, slightly inrolled when young. **PILEUS TRAMA** 1 mm at margin, to 5 mm thick over stipe, off-white, unchanging.

HYMENOPHORE lamellate. LAMELLAE subdistant, adnate to subdecurrent, 2–3 mm tall, occasionally forking at midpoint, light yellow (4A7–4A8), staining brighter yellow when bruised; edge concolorous, even; lamellulae 1–2. STIPE 30–45 mm long, 2–4 mm wide, equal, curved, dry; upper half glabrous when young, dull orangish (5C6–5C7) throughout; lower half orangish yellow; solid; trama off-white, solid, unchanging. BASAL MYCELIUM pale yellow. ODOR minimal, non-distinctive. TASTE none. SPORE DEPOSIT not obtained (FIG. 1).



FIG. 1. Basidiomata of *Phylloporus colligatus* (BRG HOLOTYPE Henkel 8026). Bar = 10 mm.

MICROCHARACTERS — BASIDIOSPORES 8.4–9.8 μm long, 3.5–4.2 μm wide, mean $Q = 2.36$, subfusoid, smooth, inamyloid, pale yellow in KOH (Fig. 2a). BASIDIA 34.3–37.8 μm long, 6.3–8.4 μm wide, clavate, pale yellow in KOH, 4-sterigmate, rarely 5 (Fig. 2b). HYMENIAL CYSTIDIA 42–45.5 μm long, 7–7.7 μm wide, more common on sides of lamellae, hyaline, clavate to fusoid (Fig. 2c) or lanceolate, thin walled, encrusting pigment absent. HYMENOPHORAL TRAMA bilateral; hyphae 4.9–7 μm wide, cylindric, yellowish. PILEIPELLIS an ixotrichodermium; hyphae cylindric, thin walled, pale yellow in KOH. PILEUS TRAMA interwoven; hyphae hyaline. STIPTIPELLIS HYPHAE vertically oriented, parallel, subcylindric or cylindric, yellow. STIPE TRAMA HYPHAE parallel, 6.3–10.5 μm wide, cylindric, pale yellow in KOH. CLAMP CONNECTIONS not observed in all the septa, rare to infrequent at basal septa of basidia and on hymenophoral trama hyphae.

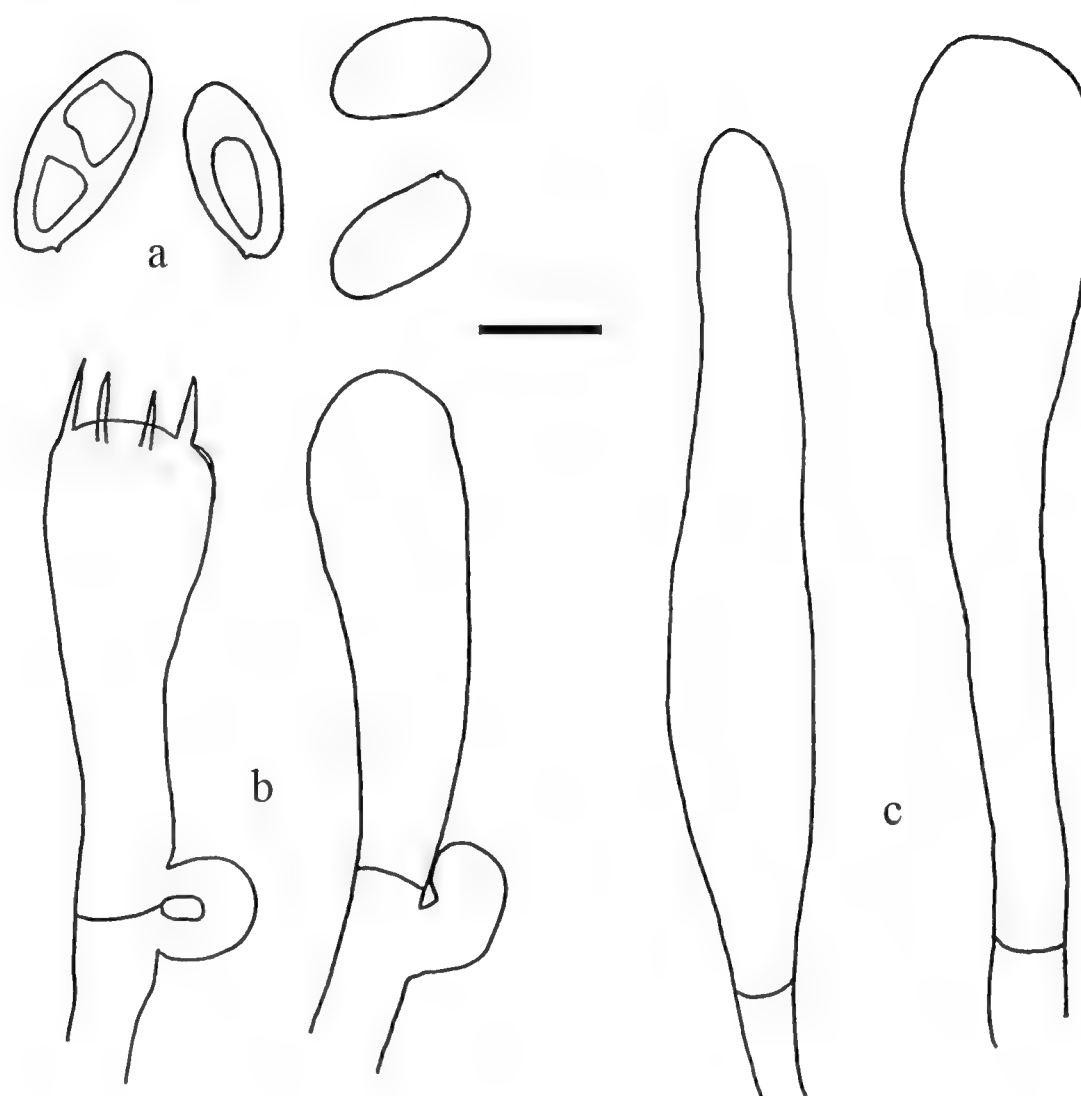


FIG. 2. Microscopic features of *Phylloporus colligatus* (BRG HOLOTYPE Henkel 8026).
a. Basidiospores. b. Basidiole and basidium with basal clamp connections. c. Hymenial cystidia.
Bar = 10 μ m.

MACROCHEMICAL REACTIONS — NH_4 instantly blue on pileus surface, rapidly changing to dull burgundy-brown. Fleeting amyloid reaction weakly positive on lamellae.

ECOLOGY, RANGE, DISTRIBUTION — Rare and solitary on root mat in forests dominated by *Dicymbe corymbosa*, known only from the type locality in the Upper Potaro River Basin of Guyana.

COMMENTS — *Phylloporus colligatus* is similar to *P. phaeoxanthus* Singer & L.D. Gómez var. *phaeoxanthus* (Singer 20583, holotype!, F), a neotropical species known from Costa Rica, Colombia, and Mexico (Singer & Gómez 1984), but the hyphae of *P. phaeoxanthus* lack clamp connections and its hymenial cystidia are encrusted. *Phylloporus colligatus* could also be confused with *P. phaeoxanthus* var. *simplex* Singer & L.D. Gómez (Singer 20623, holotype!, F), a common species in Costa Rica (Singer & Gómez 1984) that differs from

P. colligatus by its ventricose-shaped cystidia with encrusting pigment and the absence of clamp connections.

Other neotropical *Phylloporus* species with clamp connections, which might be confused with *P. colligatus*, include *P. fibulatus* Singer et al. (Ovrebo 2546, isotype!, NY) from Colombia (Singer et al. 1990) and *P. foliiporus* (Murrill) Singer (F17747, holotype!, FH) from Florida and Alabama, United States (Singer 1945). *Phylloporus fibulatus* is distinguished from *P. colligatus* by its yellow pileus with a brown NH_4 reaction, greater abundance of clamp connections seen in all tissues, cylindric to fusiform cystidia, and a subporoid hymenophore. *Phylloporus foliiporus* differs from *P. colligatus* in its larger basidiospores ($10.5\text{--}12.6 \times 4.2\text{--}4.9 \mu\text{m}$), cystidia with melleous apices, and a blue-green ammonia reaction that does not turn burgundy brown.

Among African *Phylloporus*, the only species known with clamp connections is *P. pseudopaxillus* Heinem. & Rammeloo (Heinemann & Rammeloo 1987). However, *P. pseudopaxillus* clearly differs from *P. colligatus* in having larger, longer basidiospores ($11.3\text{--}14.8 \times 3.8\text{--}4.9 \mu\text{m}$), and abundant clamp connections in all tissues of the basidioma.

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Literature cited

- Corner EJH. 1970. *Phylloporus* Quél. and *Paxillus* Fr. in Malaya and Borneo. *Nova Hedwigia* 20: 793–822.
- Dallwitz MJ. 1980. A general system for coding taxonomic descriptions. *Taxon* 29: 41–46.
- Dallwitz MJ, Paine TA, Zurcher EJ. 1993 onwards. User's guide to the DELTA system: a general system for processing taxonomic descriptions.
- Fulgenzi TD, Henkel TW, Halling RE. 2007. *Tylopilus orsonianus* sp. nov. and *Tylopilus eximius* from Guyana. *Mycologia* 99: 622–627.
- Fulgenzi TD, Mayor JR, Henkel TW, Halling RE. 2008. New species of *Boletellus* from Guyana. *Mycologia* 100: 490–495.
- Fulgenzi TD, Halling RE, Henkel TW. 2010. *Fistulinella cinereoalba* sp. nov. and new distribution records for *Austroboletus* from Guyana. *Mycologia* 102: 224–232 (DOI: 10.3852/09-059).
- Halling RE. 1989. A synopsis of Colombian boletes. *Mycotaxon* 34: 93–113.
- Halling RE, Mueller GM, Dallwitz MJ. 1999. New *Phylloporus* (*Basidiomycetes*, *Boletaceae*) with a key to species in Colombia and Costa Rica. *Mycotaxon* 73: 63–68.

- Heinemann P, Rammeloo J. 1986. *Phylloporus* (Boletineae). Flore Illustrée des Champignons d'Afrique Centrale 13: 277–309.
- Henkel TW. 1999. New taxa and distribution records of *Tylopilus* from *Dicymbe* forests of Guyana. *Mycologia* 91: 655–665.
- Henkel TW. 2003. Monodominance in the ectomycorrhizal *Dicymbe corymbosa* (Caesalpiniaceae) in Guyana. *Journal of Tropical Ecology* 19: 417–437.
- Henkel TW, Terborgh J, Vilgalys RJ. 2002. Ectomycorrhizal fungi and their leguminous hosts in the Pakaraima Mountains of Guyana. *Mycological Research* 106: 515–531.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. 8. New York Botanical Garden Press.
- Kornerup A, Wanscher HH. 1978. Methuen Handbook of Color. Eyre Methuen, London. 243 pp.
- Ladurner H, Simonini G. 2003. *Xerocomus* s.l. vol.8. Edizioni Candusso, Alassio.
- Mayor JR, Fulgenzi TD, Henkel TW, Halling RE. 2008. *Boletellus piakaii* sp. nov. and a new distribution record for *Boletellus ananas* var. *ananas* from Guyana. *Mycotaxon* 105: 387–398.
- Montoya L, Bandala VM. 1991. Studies on the genus *Phylloporus* in Mexico, I. Discussion of the known species and description of a new species and a new record. *Mycotaxon* 41: 471–482.
- Singer R. 1945. The *Boletineae* of Florida with notes on extralimital species. II. the *Boletaceae* (*Gyroporoideae*). *Farlowia* 2: 223–303.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4.ed. Koeltz Scientific Books, Koenigstein. 981 pp.
- Singer R, Gómez LD. 1984. The *Basidiomycetes* of Costa Rica. III. The genus *Phylloporus* (*Boletaceae*). *Brenesia* 22: 163–181.
- Singer R, Ovrebo CL, Halling RE. 1990. New species of *Phylloporus* and *Tricholomopsis* from Colombia, with notes on *Phylloporus boletinoides*. *Mycologia* 82: 452–459.
- Watling R, Gregory NM. 1991. Observations of the boletes of the Cooloola Sandmass, Queensland and notes on their distribution in Australia. Part 3. Lamellate taxa. *Edinburgh Journal of Botany* 48: 353–391.

New records of peltigericolous fungi from Turkey

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Abstract — Notes on seven species of peltigericolous fungi are provided. Six species (*Capronia peltigerae*, *Dacampia rufescentis*, *Neolamya peltigerae*, *Phoma peltigerae*, *Pronectria robergei*, and *Stigmidium peltideae*) are reported for the first time from Turkey.

Key words — *Ascomycota*, lichenicolous fungi, lichens, *Peltigera*

Introduction

In 2008 we began research to determine the biodiversity of the lichenized fungal genus *Peltigera* in Turkey. Thus far we have conducted field excursions covering about two thirds of Turkey from the Aegean to the Black Sea and the mountains of Anatolia including the south of the Marmara, Aegean, and Mediterranean Regions, the western South-East Region, and the East Black Sea Region including some parts of the East Anatolia Region. Previously collected *Peltigera* specimens in ANES and the Erciyes University lichen herbarium were also examined. Among the several lichenicolous fungi observed on the collected specimens, six represent new records for Turkey and are presented here.

Halıcı (2008) recently provided a key to 117 taxa of lichenicolous *Ascomycota* including mitosporic fungi with their distribution in Turkey. Since the 2008 key, additional new species have been reported and raising the number of known lichenicolous fungi to 155 taxa (Halıcı et al. 2009a). Previously, only two species of peltigericolous fungi were reported in Turkey — *Polycoccum crassum* Vězda and *Refractohilum peltigerae* (Keissl.) D. Hawksw. (Halıcı 2008). The genus *Peltigera*, considered one of the richest genera of lichenized fungus in terms of harboring lichenicolous fungi, should be more carefully examined by lichenologists (Hawksworth 1980). Keys to the peltigericolous fungi have been provided by Hawksworth (1980) and Martínez & Hafellner (1998). The species reported here bring to eight the number of peltigericolous fungi known in Turkey; at least 30 species are expected in the country.

Materials and methods

All the specimens detailed here are stored in ANES (Herbarium of Anadolu University, Science Faculty, Eskişehir, Turkey); their accession numbers are given in parentheses after the locality details. Specimens were examined in water, 10% KOH and Lugol's iodine (MERCK 9261) solutions. Ascospore measurements were determined in water. The descriptive notes provided below are based on the Turkish specimens examined.

Species recorded

Capronia peltigerae (Fuckel) D. Hawksw. 1987

A detailed description is provided by Hawksworth (1980).

Capronia peltigerae, a common lichenicolous fungus species on several *Peltigera* spp., is newly recorded from Turkey. The Turkish specimens have 3-septate, constricted ascospores that are (15–)18–21 × 6–7 µm. The ascospores are hyaline when young, pale brownish when mature, and finely verruculose, as also noted by Zhurbenko (2004) for Russian specimens. The species is pathogenic and causes bleaching in the infected zones of the host thallus.

AFYON: Emirdağ, Dandindere Tabiat Koruma Alanı: *Cedrus libani* forest, 38°50'N, 31°16'E, alt. 1500 m, on thallus of *Peltigera canina* on soil, 12 June 2008, M. Candan (ANES 12283). Küçükburun Mevkii, *Juniperus-Quercus* mixed forest, 38°50'N, 31°15'E, alt. 1500 m, on thallus of *Peltigera* sp. on mosses, 12 June 2008, M. Candan (ANES 12282).

Dacampia rufescentis (Vouaux) D. Hawksw. 1986

A detailed description is provided by Vouaux (1912) and Hawksworth (1986).

Dacampia rufescentis, a common lichenicolous fungus species on *Peltigera rufescens* (Weiss) Humb., was collected on *Peltigera praetextata* (Flörke ex Sommerf.) Vain. in Turkey. The species clearly differs from *D. peltigericola* D. Hawksw. & C.J.B. Hitch in forming circular necrotic patches in the host thallus and having ascospores with 3-longitudinal septa. *Dacampia peltigericola* has ascospores with (5–)6-longitudinal septa and does not form necrotic patches (Halıcı & Hawksworth 2008). The Turkish specimen has (6–)8-spored asci that measure 90–105 × 18–22 µm and smooth-walled reddish brown ascospores that are 25–28 × 10–12 µm.

ESKİŞEHİR: Türkmendağı, Şelale, 39°30'N, 30°32'E, alt. 1100 m, on *Peltigera praetextata* on mosses, 28 Jul. 2001, A. Özdemir Türk (ANES 6710).

Neolamya peltigerae (Mont.) Theiss. & Syd. 1918

A detailed description is provided by Keissler (1930) and Ertz (2004).

Neolamya peltigerae was collected on the thallus of *Peltigera didactyla* (With.) J.R. Laundon on mosses on serpentine in *Picea orientalis* forest. This cosmopolitan

species, mainly known on *Peltigera didactyla*, seems to be weakly pathogenic as discoloration occurs in the infected zones of the host thallus. The Turkish specimen has dispersed, immersed to slightly erumpent ascomata, ~ 300 µm, 16-spored asci, 105–113 × 25–26 µm and filiform, slightly curved, 5–7-septate ascospores that are 60–93 × 2.5–3.5 µm and have many slightly greenish oil droplets.

ARTVIN: Şavşat, North-east of Şavşat, 41°13'N, 42°22'E, alt. 1360 m, on *Peltigera didactyla* on mosses, 31 Aug. 2009, M. Candan, M. G. Halıcı & Okan Sezer (ANES 12295).

***Phoma peltigerae* (P. Karst.) D. Hawksw. 1980**

A detailed description is provided by Hawksworth (1981).

This common species was collected from four localities on three different *Peltigera* species (*P. canina* (L.) Willd., *P. elisabethae* Gyeln. and *P. rufescens*). In the Turkish specimens, discoloration in the infected zones is typical with 70–90 µm diam ± immersed pycnidia; conidia are rather abundant, narrowly ellipsoid with rounded apices, 5.5–6.5 × 2.5–3 µm. To test the speculation in Halıcı et al. (2009b), we carefully examined the *Phoma peltigerae*-infected *Peltigera* specimens to determine whether they were also infected by *Dacampia rufescentis* or *D. peltigericola*, but we failed to find any support for the anamorph-teleomorph relationship between *Phoma* and *Dacampia*.

BİLECİK: Gölpazarı, East of Kümbet Village, *Pinus nigra* forest, 40°12'N, 30°21'E, alt. 770 m, on the thallus of *Peltigera elisabethae* on mosses, 17 Nov. 2008, M. Candan & M. G. Halıcı (ANES 12288).

BURSA: Mustafakemalpaşa: South-east of Çivilica Village, *Pinus nigra* forest, 39°53'N, 48°43'E, alt. 910 m, on the thallus of *Peltigera rufescens* on mosses, 21 Nov. 2008, M. Candan & M. G. Halıcı (ANES 12289), South of Alpagut Village, *Quercus* forest, 39°51'N, 48°34'E, alt. 460 m, on the thallus of *Peltigera canina* on soil, 22 Nov. 2008, M. Candan & M. G. Halıcı (ANES 12286).

KÜTAHYA: Simav, Gölcük Yaylası Mesire Alanı, *Pinus nigra* forest, 39°09'N, 38°29'E, alt. 1340 m, on the thallus of *Peltigera canina* on soil, 23 Nov. 2008, M. Candan & M. G. Halıcı (ANES 12287).

***Polycoccum crassum* Vězda 1970**

A detailed description is provided by Hawksworth & Diederich (1988).

This species was reported from the east of Turkey in Halıcı et al. (2007). The collected specimen has abundant perithecia underside of the thallus of *Peltigera canina*, suggesting that the species is commensalistic as reported in Halıcı et al. (2007). Ascospore length is shorter in this collected specimen compared to the first collected specimen in Turkey (24–25 µm vs. 25–30 µm) (Halıcı et al. 2007); some 2-septate over-mature ascospores were also seen.

MUĞLA: Bafa Lake, South-east of Bafa Lake, 37°29'N, 27°32'E, alt. 13 m, on *Peltigera canina* on mosses, 13 Jun. 2009, M. Candan & Okan Sezer (ANES 12296).

Pronectria robergei (Mont. & Desm.) Lowen 1990

A detailed description is provided by Keissler (1930).

Pronectria robergei was collected on old and almost dead thalli of *Peltigera rufescens*. Keissler (1930), who also reported this species on dead thalli of several *Peltigera* spp., speculated that this fungus might be saprophytic. The Turkish specimen has immersed to semi-immersed orange-red perithecia that become yellowish when old, 6-spored dextrinoid asci measuring 50–60 × 10–13 µm, and hyaline, smooth walled, 1(–2)-septate ascospores that are 13.5–18 × 5–7 µm with a large oil-droplet in each cell.

ARTVIN: Şavşat, North-east of Şavşat, 41°13'N 42°22'E, alt. 1360 m, on *Peltigera rufescens* on mosses, *Picea orientalis* forest, 31 Aug. 2009, M. Candan, M. G. Halıcı & Okan Sezer (ANES 12299).

Stigmidium peltideae (Vain.) R. Sant. 1960

Detailed descriptions are provided by Santesson (1960), Hawksworth (1975), and Roux & Triebel (1994).

Stigmidium peltideae is a common species on *Peltigera* and *Solorina* spp. characterized by “type a” pseudoparaphyses. The Turkish specimen has subglobose ascomata (35–40 µm) and 1(–2)-septate ascospores (11–12 × 4–5 µm) that are only slightly constricted at the septa. The collected specimen seems to be commensalistic as no damage was observed in the host thalli of *Peltigera praetextata*.

AFYON: Akdağ Tabiat Parkı, Başalan Yaylası, 38°21'N, 30°00'E, alt. 1530 m, on *Peltigera praetextata* on mosses, 03 Jun. 2008, M. Candan (ANES 12290).

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Literature cited

- Ertz D. 2004. *Neolamya*. pp. 677–678, in Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F. 2004. Lichen flora of the Greater Sonoran Desert Region. Vol. 2. Tempe: Arizona State University.
- Halıcı MG. 2008. A key to the lichenicolous *Ascomycota* (including mitosporic fungi) of Turkey. *Mycotaxon* 104: 253–286.
- Halıcı MG, Hawksworth DL. 2008. Two new species of *Dacampia*, with a key to and synopsis of the known species of the genus. *Fungal Diversity* 28: 49–54.
- Halıcı MG, Özdemir Türk A, Candan M. 2007. New records of pyrenocarpous lichenicolous fungi from Turkey. *Mycotaxon* 99: 201–206.
- Halıcı MG, Candan M, Özdemir Türk A. 2009a. Notes on some lichenicolous fungi species from Turkey II. *Turkish Journal of Botany* 33: 389–392.
- Halıcı MG, Candan M, Calatayud V. 2009b. *Dacampia rubra* (*Ascomycota*, *Dacampiaceae*), a new lichenicolous fungus on vagrant *Aspicilia* species. *Mycotaxon* 108: 235–240.

- Hawksworth DL. 1975. Notes on British lichenicolous fungi, I. Kew Bull. 30: 183–203.
- Hawksworth DL. 1980. Notes on some fungi occurring on *Peltigera*, with a key to accepted species. Trans. Br. Mycol. Soc. 74: 363–386.
- Hawksworth DL. 1981. The lichenicolous coelomycetes. Bull. Br. Mus. nat. Hist., Bot. 9: 1–98.
- Hawksworth DL. 1986. Notes on British lichenicolous fungi: V. Notes Roy. Bot. Gdn. Edinb. 43: 497–519.
- Hawksworth DL, Diederich P. 1988. A synopsis of the genus *Polycoccum* (*Dothideales*), with a key to accepted species. Trans. Br. Mycol. Soc. 90: 293–312.
- Keissler K. 1930. Die Flechtenparasiten. Rabenhorst's Kryptogamen-Flora von Deutschland, Oesterreich und der Schweiz 8: i– xi, 1–712.
- Martínez I, Hafellner J. 1998. Lichens and lichenicolous fungi on Peltigerales in the Iberian Peninsula and the Canary Islands. Mycotaxon 69: 271–310.
- Roux C, Triebel D. 1994. Révision des espèces de *Stigmidium* et de *Sphaerellothecium* (champignons lichénicoles on lichénisés, ascomycetes) correspondant à *Pharcidia epicymatia* sensu Keissler ou à *Stigmidium schaereri* auct. Bull. Soc. Linn. Provence 45: 451–542.
- Santesson R. 1960. Lichenicolous fungi from northern Spain. Svensk Bot. Tidskr. 54: 499–522.
- Vouaux MLA. 1912. Synopsis des Champignons parasites de Lichens. Bull. Trimest. Soc. Mycol. Fr. 29: 33–128.
- Zhurbenko MP. 2004. Lichenicolous and some interesting lichenized fungi from the Northern Ural, Komi Republic of Russia. Herzogia 17: 77–86.

Two new dictyosporous hyphomycetes on *Rhopalostylis sapida* (Arecaceae) in New Zealand

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Abstract—*Dictyosporium hughesii* sp. nov. and *D. rhopalostylidis* sp. nov., found on dead leaves of the palm, *Rhopalostylis sapida* in New Zealand are illustrated and described and compared with related taxa.

Key words—anamorphic fungi, taxonomy

Introduction

The palm genus *Rhopalostylis* contains two taxa: *R. baueri* (endemic to Norfolk Island and to Raoul Island, Kermadec Islands) and the world's southern-most palm, *R. sapida* (endemic to mainland New Zealand). Palms are a favourable substrate for microfungi, and many species have been described from them (Taylor & Hyde 2003, McKenzie 2009). While examining dead leaf tissues of *R. sapida*, two new species of *Dictyosporium* were found. One of the new species (based on herbarium specimen PDD 20966) was previously recorded on *R. sapida* under the name *D. elegans* Corda (McKenzie et al. 2004).

Several species of *Dictyosporium* have been recorded on palms in various parts of the world. Of the 22 species of *Dictyosporium* accepted by Goh et al. (1999), eight (*D. alatum* Emden, *D. campaniforme* Matsush., *D. cocophyllum* Bat., *D. digitatum* J.L. Chen et al., *D. elegans*, *D. heptasporum* (Garov.) Damon, *D. subramanianii* B. Sutton, *D. tetraseriale* Goh et al.) were listed on palms.

Materials and methods

Portions of leaf sheath from dead, fallen fronds of nikau palm (*Rhopalostylis sapida*) were collected from the forest floor. The plant material was incubated under humid conditions and periodically examined for sporulating microfungi. A dried herbarium specimen of a new *Dictyosporium* species was prepared and deposited in the New Zealand Fungal Herbarium (Herb. PDD). In addition, a specimen collected in 1963 and held in Herb. PDD under the name *D. elegans* was re-examined. Fungal fruiting structures were removed, mounted



FIG. 1. Conidia of *Dictyosporium hughesii* (from holotype). Note apical appendages, especially on upper right conidium and conidiogenous cell attached to lower right conidium. Specimen mounted in hydrous lactophenol. Scale bar = 20 µm.

in lactophenol, and examined by light microscopy. Measurements were made on material mounted in lactophenol.

Taxonomy

Colonies of *Dictyosporium* are often in the form of compact sporodochia, but the genus is characterised by having micronematous conidiophores and conidia with orderly rows of cells arranged either flattened in one plane (complanate) or not flattened. The number of rows of cells is usually constant within a species. Goh et al. (1999) revised the genus *Dictyosporium* and provided a key to the species. A key was also provided by Cai et al. (2003) and most recently by Crous et al. (2009). Two specimens collected in New Zealand on dead leaves of *Rhopalostylis sapida* are distinct from hitherto known species of *Dictyosporium* and described below as *D. hughesii* and *D. rhopalostylidis*.

***Dictyosporium hughesii* McKenzie, sp. nov.**

MYCOBANK: MB 515243.

Coloniae sporodochia, punctiformes, dispersae, pulvinatae, nigrae. Mycelium ex hyphis in substrato immersum, Conidiophora micronematosa, mononematosa, aseptata,

FIG. 1

subhyalinae, tenuitunicata, laevia. Cellulae conidiogenae holoblasticae, determinatae, cylindricae, hyalinae, 3.5–5 µm latae. Conidia solitaria, sicca, acrogena, brunnea, laevia, complanata, ellipsoidea, cheiroidea, in 51–62 cellulis (6–)7-serietibus composita, constricta, (33–)40–47(–50) × (23–)25–30(–32) µm; cellula apicalis serietibus cum appendicibus subglobosa, hyalinis, usque ad 13 µm longa, 10 µm crassa, praedita.

ETYMOLOGY: named after S.J. Hughes, doyen of New Zealand dematiaceous hyphomycete taxonomy.

TYPE: NEW ZEALAND, Auckland, Waitakere Ranges, Rangemore Track, in foliis mortuis arecearum *Rhopalostylis sapida* H. Wendl. & Drude (*Arecaceae*), 8 May 1963, S.J. Hughes (PDD 20966, holotype).

COLONIES with punctiform sporodochia, scattered but coalescing, black, irregular in shape. MYCELIUM immersed. CONIDIOPHORES reduced to conidiogenous cell, micronematous, mononematous, subhyaline, thin-walled, smooth. CONIDIOGENOUS CELLS holoblastic, determinate, cylindrical, 3.5–5 µm wide. CONIDIA solitary, dry, acrogenous, medium brown, concolourous, smooth-walled, complanate, ellipsoidal, cheiroid, consisting of 51–62 cells arranged in 7 closely adpressed rows arising from a 4.5–7 µm wide basal cell; basal cell typically rounded or diamond-shaped but sometimes truncate; inner rows extending the furthest, outer rows extending about two-thirds of the way along the conidium, each row containing 6–9 cells, constricted at septa, slightly thickened walls and septa, no pores visible on septa, (33–)40–47(–50) × (23–)25–30(–32) µm (mean = 43.7 × 27.8 µm, n = 30), apical cell of two outer rows sometimes become a swollen, out-curved, subglobose, hyaline appendage up to 13 µm long × 10 µm wide.

COMMENTS: Twelve species of *Dictyosporium* have been described with conidia bearing variedly developed appendages (Crous et al. 2009). Of these, only the conidia of *D. musae* Photita (Photita et al., 2002) consistently comprise 7 rows of cells. However, the conidia of *D. musae* are smaller than those of *D. hughesii* (22–28 × 12.5–18 µm vs. 33–50 × 23–32 µm), not complanate, and the appendages arise from middle cells of the outer rows. *D. strelitziae* Crous & A.R. Wood is similar to *D. hughesii* in having complanate conidia with apical appendages on the outer rows. However, conidia of the former have predominantly only 5 rows of cells and measure 30–55 × 20–25 µm, while conidia of *D. hughesii* have 7 rows of cells and are wider. Appendages are evident on only a minority of the conidia of *D. hughesii*. This may be the natural condition, or it may be due to the age of the collection (almost 50 years old). Among those species of *Dictyosporium* that apparently lack appendages, *D. hughesii* keys out with *D. polystichum* (Höhn.) Damon and *D. toruloides* (Corda) Guég. (Crous et al. 2009). However, the number of rows of cells in the conidia of both of these species is irregular [(5–)7–9 rows in *D. polystichum* and (5–)6–8 rows in *D. toruloides*], and the rows are unequal in length reaching to markedly different heights of the conidium (Goh et al. 1999).

Taylor & Hyde (2003) recorded a *Dictyosporium* species, which they tentatively identified as *D. elegans* on a palm, *Archontophoenix alexandrae*, in Australia. Their specimen bore complanate conidia with 6–8 rows of cells (average 7), but the conidia measured $38\text{--}92 \times 28\text{--}42 \mu\text{m}$ (mean $76 \times 33.8 \mu\text{m}$), which is considerably larger than the conidia of *D. hughesii*.

***Dictyosporium rhopalostylidis* McKenzie, sp. nov.**

FIG. 2

MYCOBANK: MB 515244.

Coloniae punctiformes, dispersae, pulvinatae, nigrae. Mycelium ex hyphis in substrato immersum, Conidiophora micronematosa, mononematosa, aseptata, subhyalinae, tenuitunicata, laevia. Cellulae conidiogenae holoblasticae, determinatae, cylindricae, pallide brunneae, 2–3 μm latae. Conidia solitaria, sicca, acrogena, brunnea, laevia, complanata, ellipsoidea, cheiroidea, in 30–40(–48) cellulis 5–6-serietibus composita, constricta, (28–)31–42(–48) \times 20–27(–29) μm .

ETYMOLOGY: named after the host plant, *Rhopalostylis sapida*.

TYPE: NEW ZEALAND, Wellington, Paraparaumu, Nikau Reserve, in foliis mortuis areacearum *Rhopalostylis sapida* H. Wendl. & Drude (*Arecaceae*), 12 May 2009, E.H.C. McKenzie (PDD 97449, holotype).

COLONIES with punctiform, sporodochial conidiomata, scattered, pulvinate, black, irregular in shape. *Mycelium* immersed. CONIDIOPHORES reduced to conidiogenous cell, micronematous, mononematous, subhyaline, thin-walled, smooth. CONIDIOGENOUS CELLS holoblastic, determinate, cylindrical, pale brown, 2–3 μm wide. CONIDIA solitary, dry, acrogenous, brown, concolourous, smooth-walled, complanate, ellipsoidal, cheiroid, consisting of 30–40(–48) cells arranged in 5–6 closely adpressed rows arising from a 4–5.5 μm wide basal cell, basal cell typically rounded or diamond-shaped but sometimes truncate, often with a small, persistent portion of the conidiogenous cell, each row reaching to more or less the same height, containing 5–10 cells, constricted at septa, slightly thickened walls and septa, no pores visible on septa, (28–)31–42(–48) \times 20–27(–29) μm (mean = $35.2 \times 28.5 \mu\text{m}$, $n = 30$), each cell 3–5.5 μm long, 3.5–6 μm wide.

COMMENTS: The conidia of *Dictyosporium rhopalostylidis* are morphologically similar to those of *D. elegans*, which has mostly 5 rows of cells. However, the conidia of *D. elegans* are larger, consisting of 51–96 cells and measuring (44–) 50–80 \times 24–31(–36) μm . In addition, the colonies of *D. elegans* are not in the form of sporodochia (Goh et al. 1999).

There are morphological similarities between *D. hughesii* and *D. rhopalostylidis*. However, the conidia of *D. hughesii* are slightly longer and composed of more cells, which are consistently arranged in 7 rows. The rows of cells in conidia of *D. rhopalostylidis* reach to approximately the same height, whereas in *D. hughesii* they extend to different heights. *Dictyosporium rhopalostylidis* also lacks the apical appendages found in *D. hughesii*.

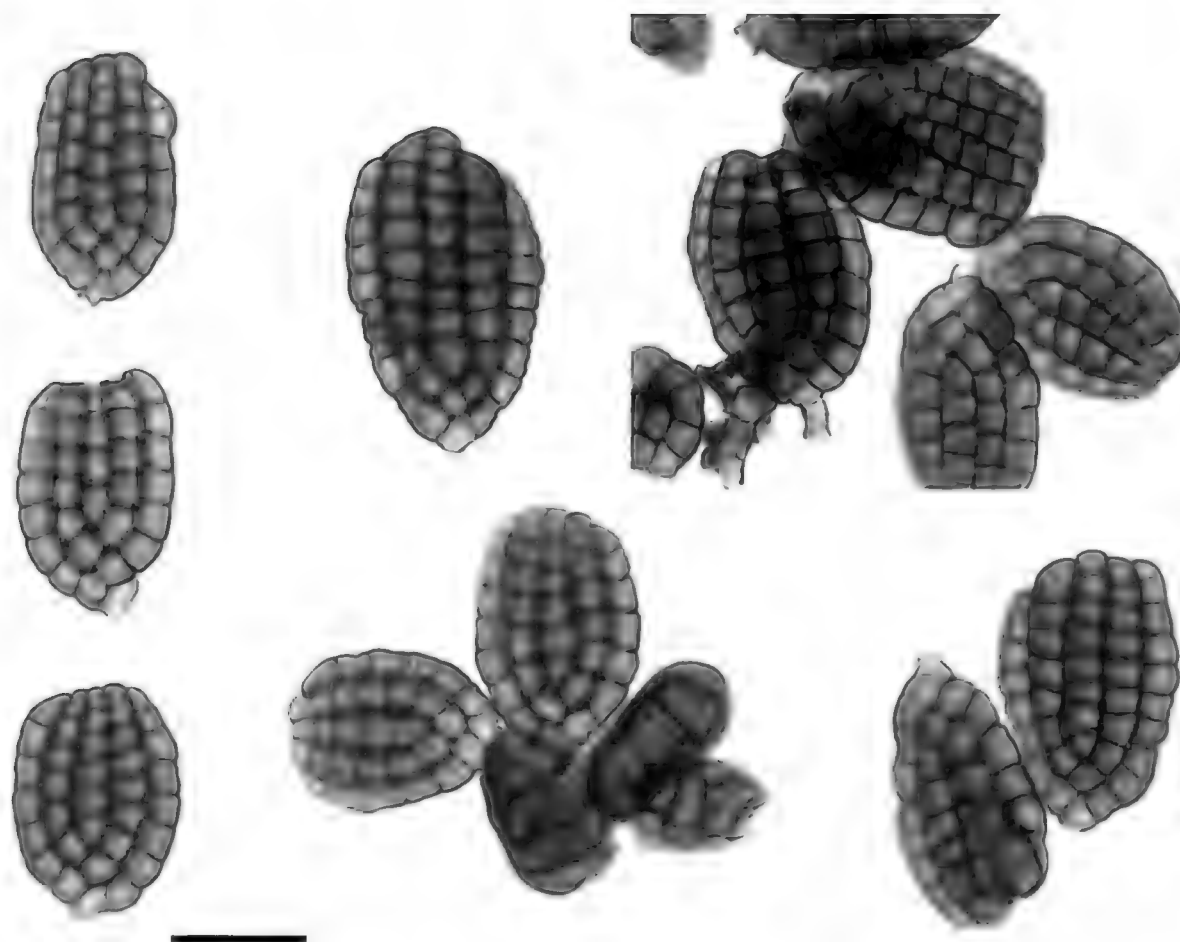


FIG. 2. Conidia of *Dictyosporium rhopalostylidis* (from holotype). Specimen mounted in hydrous lactophenol. Scale bar = 20 μ m.

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Literature cited

- Cai L, Zhang K, McKenzie EHC, Lumyong S, Hyde KD. 2003: New species of *Canalisporium* and *Dictyosporium* from China and a note on the differences between these genera. *Cryptogamie, Mycologie* 24: 3–11.
- Crous PW, Braun U, Wingfield MJ, Wood AR, Shin HD, Summerell BA, Alfenas AC, Cumagun CJR, Groenewald JZ. 2009: Phylogeny and taxonomy of obscure genera of microfungi. *Persoonia* 22: 139–161.
- Goh T-K, Hyde KD, Ho WH, Yanna. 1999. A revision of the genus *Dictyosporium*, with descriptions of three new species. *Fungal Diversity* 2: 65–100.

- McKenzie EHC. 2009: A new species of *Lylea* (hyphomycetes) on *Rhopalostylis* (*Arecaceae*) in New Zealand. *Mycotaxon* 109: 39–42.
- McKenzie EHC, Buchanan PK, Johnston PR. 2004: Checklist of fungi on nikau palm (*Rhopalostylis sapida* and *R. baueri* var. *cheesemanii*) in New Zealand. *New Zealand Journal of Botany* 42: 335–355.
- Photita W, Lumyong P, McKenzie EHC, Hyde KD, Lumyong S. 2002: A new *Dictyosporium* species from *Musa acuminata* in Thailand. *Mycotaxon* 82: 415–419.
- Taylor JE, Hyde KD. 2003: Microfungi of tropical and temperate palms. *Fungal Diversity Research Series* 12.

Five lichens of *Leptogium* new to China

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Abstract—Three lichen species are recorded as new to China: *Leptogium furfuraceum*, *L. hibernicum*, and *L. papillosum*. *Leptogium arisanense* and *L. burnetii* are also reported as new to mainland China.

Key words—Tibet Plateau, Qinling Mountains, taxonomy

Introduction

Leptogium (Ach.) Gray is a subcrustose to foliose and gelatinous lichen genus belonging to *Collema*taceae, *Peltigerales*, *Ascomycota* (Miadlikowska & Lutzoni 2004). The genus is characterized by having the cyanobacterium *Nostoc* as primary photobiont, a homoiomerous corticated thallus and laminal zeorine apothecia, the septate, usually submuriform to muriform ascospores, and the absence of lichen substances (Sierk 1964, Jørgensen 1973, 1975, Galloway 1999). The genus comprises about 189 species worldwide (Kirk et al. 2008). In China, *Leptogium* includes 26 species, of which 15 species are found in mainland China and 20 species in Taiwan (Wei 1991, Jørgensen 1997, Lai 2000, Aptroot et al. 2002). During our study of this genus in China, three species new to China and two species new to mainland China were discovered, namely *L. furfuraceum*, *L. hibernicum*, *L. papillosum*, *L. arisanense* and *L. burnetii*. The thalli of all five species have tomentum. All the *Leptogium* species with tomentum have been summarized by Jørgensen (1997).

In addition, Jiang (1994) described three species new to science from China, *L. xiaowutaicum*, *L. hebeiense*, and *L. yunnanense*. However, the type specimens of these three species were not found in the mentioned Herbaria (HBNU and HMAS-L). According to the description by Jiang (1994), we

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think that *L. xiaowutaicum* represents *L. menziesii*, and *L. hebeiense* should be *L. saturninum*. Because most specimens collected by us from the type locality of *L. xiaowutaicum* and *L. menziesii* belong to *L. menziesii* or *L. saturninum* and the necessary description of *L. yunnanense* is lacking, we have not included the three new species reported by Jiang (1994) in our study.

Material and methods

The specimens studied are housed in SDNU (Shandong Normal University) and HMAS-L (Lichen Section, Herbarium of the Institute of Microbiology, Academia Sinica). The morphology and anatomy of lichen specimens were examined using a stereo (Motic K-400L) and light (JNOEC XS-213) microscope. An AO Histostat Microtome was routinely used for frozen sections. Photographs were taken with Olympus Cover-018.

New records

1. *Leptogium furfuraceum* (Harm.) Sierk, Bryologist 67: 266 (1964).

Thallus 2.5–4.5 cm in diameter, foliose, corticolous, loosely attached; upper surface brown when dry, with distinct wrinkles, somewhat shiny; lobes orbicular, about 1 cm broad, the margins entire and somewhat undulate, commonly turning under; isidia cylindrical to clavate with a minute pit in the apex, brown, sometimes shiny; lower surface covered with white tomentum. Lobes 75–300 µm thick; cortex cells on both sides, 7.5–10 µm in diameter; nostoc-cells spherical to elongate, 3.5–5 µm in diameter, in chains throughout thallus, but most abundant near the upper cortex; hyphae 2–3 µm in diameter, irregularly and loosely interwoven; hairs composed of cylindrical cells, 6–7 µm in diameter, longer than 100 µm.

Apothecia not seen.

COMMENTS — *Leptogium furfuraceum* is closely related to *L. pseudofurfuraceum*. Both species have a brown thallus, densely wrinkled upper surface, and cylindrical to clavate isidia with a minute pit in the apex. However, *L. furfuraceum* can be separated from *L. pseudofurfuraceum* by the darker colored, more densely wrinkled upper surface and smaller spores. In addition, *L. pseudofurfuraceum* is primarily restricted to North America, while *L. furfuraceum* is nearly cosmopolitan.

L. furfuraceum has been reported from Europe, Africa, North America, and India (Sierk 1964, Awasthi & Akhtar 1977, Jørgensen 1997, Aragón et al. 2005). New to China.

SPECIMEN EXAMINED: CHINA. Yunnan, Shangri-la County, alt. 3500 m, on bark, Z.J. Ren, 3 Nov. 2008 (SDNU: 20082160-1).

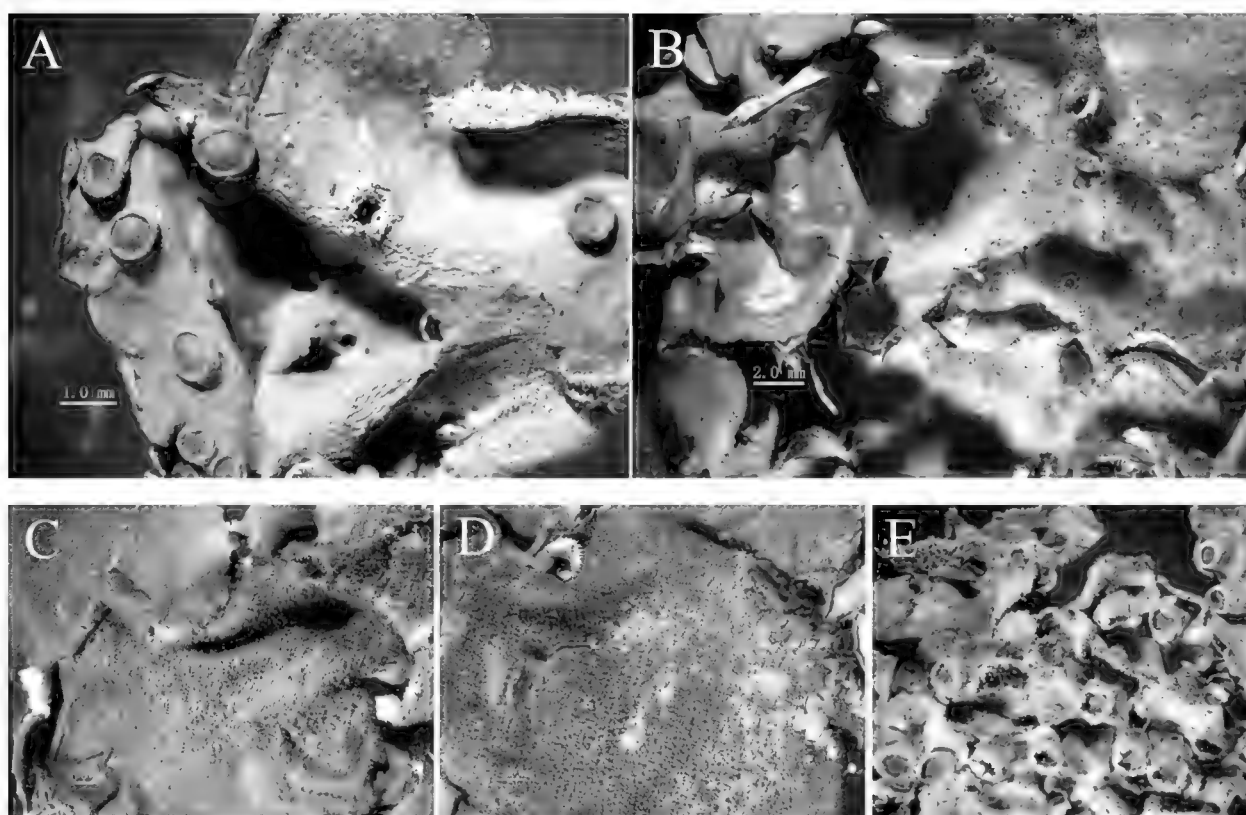


FIG. 1. *Leptogium* species examined in the present study. A. *L. arisanense*, QL590 X.L. Shi & S.X. Guo (SDNU); B. *L. burnetii*, 20080433-2 Z.J. Ren (SDNU); C. *L. furfuraceum*, 20082160-1 Z.J. Ren (SDNU); D. *L. hibernicum*, SH139 X.L. Shi & S.X. Guo (SDNU); E. *L. papillosum*, 031557 J.D. Zhao & L.W. Xu (HMAS-L). Scale bars: A,C,D = 1mm; B,E = 2 mm.

2. *Leptogium hibernicum* M.E. Mitch. ex P.M. Jørg., Herzogia 2: 462 (1973).

Thallus 2–3.5 cm in diameter, foliose, corticolous, loosely attached; upper surface blue grey when dry, with striate wrinkles, not glossy; lobes orbicular, about 1 cm broad, the margins entire to somewhat undulate, commonly turning under; isidia laminal, granular to subcylindrical, commonly branching or sometimes squamulose, somewhat darker than thallus; lower surface covered with pale tomentum. Lobes 280–350 μm thick; upper cortex cells 3–4 μm in diameter, lower cortex cells 4.5–7 μm in diameter; nostoc-cells in chains throughout thallus, spherical to ellipsoidal, 2.5–4 μm in diameter; hyphae 2–3 μm in diameter, loosely interwoven; hairs composed of spherical cells, 5–6 μm in diameter, shorter than 30 μm .

Apothecia not seen.

COMMENTS —Most *Leptogium* species with tomentum have long hairs with cylindrical cells except *L. hibernicum* and *L. laceroides*. Although both those species have short hairs with spherical cells, *L. hibernicum* can be distinctly separated from *L. laceroides* by the striate rather than smooth upper surface, the thicker thallus (280–350 μm cf. 80–120 μm), the broader lobes (1–1.5 cm cf. 0.3–0.6 cm), and the laminal rather than marginal and laminal isidia.

L. hibernicum has been reported from Europe, Africa, North America, South America, W. Indies, and New Guinea (Jørgensen 1975 1997, Aragón et al. 2005). New to China.

SPECIMEN EXAMINED: CHINA. Shaanxi, Ningshan County, alt. 1500 m, on bark, S.X. Guo & X.L. Shi, 28 Jul. 2005 (SDNU: SH139); C.L. Wang & F. Yang, 27 Jul. 2005 (SDNU: NSW030).

3. *Leptogium papillosum* (B. de Lesd.) C.W. Dodge, Ann. Missouri Bot. Gard. 20: 422 (1933).

Thallus 5.5–7 cm in diameter, foliose, saxicolous, loosely attached; upper surface gray to bluish gray when dry, with distinct wrinkles; lobes irregular, orbicular, about 1 cm broad, the margins entire to crenate and isidiate, sometimes turning under; isidia laminal or sometimes marginal, semiglobular to clavate, sometimes wrinkled, simple or irregularly branched, concolorous with the thallus; lobules present, laminal; lower surface covered with pale brown tomentum. Lobes 120–160 μm thick; upper cortex 5–6 μm thick, lower cortex 7.5–9 μm thick; nostoc-cells in chains throughout thallus, spherical to ellipsoidal, 3–7.5 μm in diameter; hyphae 2.5–3.5 μm in diameter, loosely interwoven; hairs composed of cylindrical cells, 6–7 μm in diameter, about 200 μm long.

Apothecia frequent, laminal, stipitate, 1–3 mm in diameter; the disc concave, brown to red-brown; exciple thalline, with white hairs, concolorous with the thallus, margin usually with isidia; the euparaplectenchymatous layer above the cyanobiont layer 75–85 μm thick; spores 8, muriform, ellipsoid, 25–30 \times 9–11 μm , 3–4-septate transversely, 1-septate longitudinally.

COMMENTS —*Leptogium papillosum* is similar to *L. pseudopapillosum*. These two species both have a bluish gray thallus with isidia and dense wrinkles. However, *L. papillosum* can be separated from *L. pseudopapillosum* by the clavate rather than coralloid isidia, the thinner thallus (up to 160 μm cf. up to 400 μm), and the abundant (rather than very rare) apothecia. Although *L. papillosum* is usually corticolous, the Chinese specimen reported here is saxicolous.

Leptogium papillosum has been reported from North America, South America, and India (Awasthi & Akhtar 1977, Jørgensen 1997, Jørgensen & Nash 2004). New to China.

SPECIMEN EXAMINED: CHINA. Anhui, Mt. Huangshan, alt. 630 m, on rock, J.D. Zhao & L.W. Xu, 27 Aug. 1962 (HMAS-L: 031557).

4. *Leptogium arisanense* Asahina, J. Jap. Bot. 12: 252 (1936).

Thallus 2.5–3.5 cm in diameter, foliose, corticolous, flat, spreading, loosely attached; upper surface bluish grey when dry, not glossy, with distinct wrinkles; lobes orbicular, discrete, 0.6–1 cm broad, the margins entire, regular to wavy;

isidia absent; lower surface covered with white tomentum. Lobes 100–210 μm thick; cortex cells on both sides 6–10 μm in diameter; nostoc-cells spherical to elongate, 5–7 μm in diameter, in chains throughout thallus; hyphae 3–4 μm in diameter, irregularly interwoven; hairs longer than 100 μm , composed of cylindrical cells, 4–6 μm in diameter.

Apothecia frequent, submarginal to laminal, sessile, 1–2 mm in diameter; the disc concave to convex, orange-brown to red-brown; exciple thalline, irregularly to periclinally wrinkled, concolorous with the thallus, usually with moderately hairs; the euparaplectenchymatous layer above the cyanobiont layer 25–30 μm thick; spores 8, muriform, ellipsoid, $24\text{--}29 \times 9\text{--}12.5\mu\text{m}$, 4–6 septate transversely, 1–2 septate longitudinally.

COMMENTS —*Leptogium arisanense* is characterized by the distinctly wrinkled bluish grey thallus and the sessile apothecia with long marginal hairs.

Leptogium arisanense has been reported from India, New Guinea, and Taiwan (China) (Awasthi & Akhtar 1977, Jørgensen 1997). New to mainland China.

SPECIMEN EXAMINED: CHINA. Shaanxi, Mt. Taibaishan, alt. 2070 m, on bark, X.L. Shi & S.X. Guo, 2 Aug. 2005 (SDNU: QL590).

5. *Leptogium burnetii* C.W. Dodge, Beih. Nov. Hedw. 12: 120 (1964).

Thallus 3–8 cm in diameter, foliose, corticolous, loosely attached; upper surface bluish gray when dry, glossy and obviously shiny; lobes orbicular, 1–2 cm broad, margins sometimes crenate; isidia abundant, mainly laminal, cylindrical to coralloid, slightly darker than the thallus; lower surface covered with white tomentum. Lobes 90–125 μm thick; upper cortex 5–7 μm thick, lower cortex 8–12 μm thick; nostoc-cells usually spherical, 4.5–6 μm in diameter, in chains throughout thallus, but most abundant near the upper cortex; hyphae 3–4.5 μm in diameter, irregularly interwoven; hairs with cylindrical cells, 6–7 μm in diameter, usually 150–250 μm long.

Apothecia not seen.

COMMENTS —*Leptogium burnetii* is superficially similar to *L. saturninum*, but the former can be readily distinguished by the crenate, rather than entire lobes, and the cylindrical coralloid, rather than granular, isidia.

L. burnetii has been reported from North America, South America, Europe, Africa, Russia, Pakistan, Hawaii, Japan, and Taiwan (China) (Aragón et al. 2004, 2005). New to mainland China.

SPECIMEN EXAMINED: CHINA. Yunnan, Shangri-la County, alt. 3500 m, on bark, Z.J. Ren, 3 Nov. 2008 (SDNU: 20081365, SDNU: 20082160); Sichuan, Litang County, alt. 4200 m, on bark, 5 Nov. 2008, Z.J. Ren (SDNU: 20080433-2), H.Y. Wang (SDNU: 20080541), Z.S. Sun (SDNU: 20080638); Mt. Gongga, alt. 1900–2100 m, on bark, X.Y.

Wang et al., 5 Aug. 1982 (HMAS-L: 031726, HMAS-L: 031728); **Hunan**, Sangzhi County, alt. 1380–1500 m, on bark, J.B. Chen et al., 20 Aug. 1997 (HMAS-L:031562, HMAS-L: 031564, HMAS-L: 031571); **Hubei**, Mt. Shennongjia, alt. 1900 m, on bark, J.B. Chen, 8 Sep. 1984 (HMAS-L: 031440).

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Literature cited

- Aragón G, Otalora MAG, Martinez I. 2005. New data on the genus *Leptogium* (lichenized ascomycetes) in the Iberian Peninsula. *Nova Hedwigia* 80(1–2): 199–226.
- Aragón G, Martínez I, Otálora MAG. 2004. New data on the distribution of *Leptogium azureum* (Swartz) Mont. *Lichenologist* 36(5): 345–347.
- Aptroot A, Sparrius LB, Lai MJ. 2002. New Taiwan macrolichens. *Mycotaxn* 84: 281–292.
- Awasthi DD, Akhtar P. 1977. The genus *Leptogium* (sect. *Mallotium*) in India. *Norwegian Journal of Botany* 24: 59–71.
- Galloway DJ. 1999. Notes on the lichen genus *Leptogium* (*Collemataceae*, *Ascomycota*) in New Zealand. *Nova Hedwigia* 69(3–4): 317–355.
- Jiang ZG. 1994. Reports of the new species and variety from P. R. China. *Journal of Hebei Normal University (Natural Science)* 1: 65–68.
- Jørgensen PM. 1973. On some *Leptogium* species with short *Mallotium* hairs. *Svensk Botanisk Tidskrift* 67: 53–58.
- Jørgensen PM. 1975. Contributions to a monograph of the *Mallotium*–hairy *Leptogium* species. *Herzogia* 3: 433–460.
- Jørgensen PM. 1997. Further notes on hairy *Leptogium* species. *Symbolae Botanicae Upsalienses* 32(1): 113–130.
- Jørgensen PM, Nash TH III. 2004. *Leptogium*. In: Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F (eds), *Lichen flora of the Greater Sonoran Desert Region*, Vol. 2. *Lichens Unlimited*, Arizona State University, Tempe, Arizona. 330–350.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA (eds). 2008. *Ainsworth & Bisby's dictionary of the fungi*. 10th edition. CAB International, Wallingford Oxon. 1–771.
- Lai MJ. 2000. *Illustrated macrolichens of Taiwan*. The council of Agriculture Publisher, Taiwan. 1–229.
- Miadlikowska J, Lutzoni F. 2004. Phylogenetic classification of peltigeralean fungi (*Peltigerales*, *Ascomycota*). *American Journal of Botany* 91(3): 449–464.
- Sierk HA. 1964. The genus *Leptogium* in North America, north of Mexico. *Bryologist* 67: 245–317.
- Wei JC. 1991. *An enumeration of lichens in China*. International Academic Publishers, Beijing. 1–27.

Three new species of *Stemphylium* from Sinkiang, China

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Abstract — Three new species of *Stemphylium* discovered from diseased leaves of *Ixeris denticulata*, *Brassica pekinensis*, and *Malus sieversii* in Sinkiang province of Northwest China, are described as *Stemphylium ixeridis*, *S. brassicicola*, and *S. microsporum*. They are compared to similar morphological species.

Key words — hyphomycetes, fungi, taxonomy

Introduction

Wallroth (1833) erected the genus *Stemphylium* based on the type species, *Stemphylium botryosum* Wallr. Wiltshire (1938) examined available type specimens of *Stemphylium* species and the descriptive literature fundamental to the current concepts of *Stemphylium*. Simmons (1967) delineated the genus, which shares several characters with *Alternaria* and *Ulocladium*, including muriform, usually pigmented conidia; it can be separated from *Alternaria* and *Ulocladium* by the following criteria (Simmons 1967): (i) The percurrently proliferating conidiophore is the principal morphological characteristic of *Stemphylium* and (ii) the apical cell of a simple *Stemphylium* conidiophore is slightly to distinctly swollen. There are 33 published names that represent recognizable taxa of *Stemphylium* (Câmara et al. 2002). The taxonomic classification of *Stemphylium* is primarily based on the morphological characteristics of conidia including variation in conidial shape, size, length/width ratio, color, septation, and ornamentation, and length of the conidiophore and diameter of the terminal, swollen apical cell of the conidiophore (Simmons 1967, 1969, 1990, 2001, 2002, 2004; Weber 1930; Yamamoto 1960). In recent years numerous *Stemphylium* spp. were isolated from leaf spots of different plants in China. Among them are three new species from necrotic leaf spots on *Ixeris denticulata*, *Brassica pekinensis* and *Malus sieversii* in Sinkiang province, China. They are illustrated and described and compared morphologically to similar species.

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Materials and methods

The specimens were collected from black spots on living leaves of plants during 2008–09. Fungi were isolated by moistening the leaves, then picking single conidia growing from the tissues in Petri dishes. Those isolates were cultured on PDA (potato-dextrose agar) at 23°C and transferred to PCA (potato-carrot agar) after 3–5 days. Morphological descriptions of *Stemphylium* spp. were based on cultures that developed under standardized conditions (Simmons & Roberts 1993): potato-carrot agar (PCA) at ambient room temperature 23°C, under a daily fluorescent light/dark cycle of 8/16 h, and examined after 2–3 weeks. All microscopic characteristics were determined on the basis of measurements of 50 mature conidia and 30 conidiophores mounted in lactic acid at 100 × magnification.

Taxonomic descriptions

Stemphylium ixeridis Y.F. Pei & X.G. Zhang, sp. nov.

FIGURE 1

MYCOBANK MB 515425

Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, pallide brunneae. Mycelium superficiale, hyphae ramosae, septatae, pallide brunneae, laeves, 3.5–4.5 µm latae. Conidiophora solitaria, nonramosa vel raro ramosa, pallide brunnea, laevia, cylindrica, 16–22-septata, 685–765 × 3.5–5.5 µm. Apex conidiogenus, brunneus, usque 7.5–9.0 µm dilatatus, dense guttulatus, semel proliferens. Conidia singula in apice conidiophori, subsphaerica, ovoidea vel late ellipsoidea, sursum rotundata, deorsum rotundata vel subtruncata, 1–2(–3) septis transversalibus et 0–2 septis longitudinalibus vel obliquis divisa, in medio distincte constricta, 30–45 × 18–26 µm, medio-brunnea vel atro-brunnea, dense verrucosa.

HOLOTYPE: on leaves of *Ixeris denticulata* (Houtt.) Stebbins (Asteraceae), a kaleyard of Korla, Sinkiang province, Northwestern China. Aug. 6. 2009, Y.F. Pei, HSAUPpyf1837, the ex-type culture is preserved in the Centraalbureau voor Schimmelcultures (CBS), No. CBS 124748.

ETYMOLOGY: in reference to the host genus, *Ixeris*.

Colonies on PCA effuse, pale brown. Mycelium superficial, hyphae branched, septate, pale brown, smooth, 3.5–4.5 µm wide. Conidiophores solitary, unbranched or occasionally branched, pale brown, smooth, cylindrical, 16–22-septate, 685–765 × 3.5–5.5 µm (FIG. 1A–B). Conidiogenous cells swollen at the apex, brown, 7.5–9.0 µm wide, densely guttulate, occasionally with 1 apical proliferation (FIG. 1B–C). Conidia developing singly, subspherical, ovoid or broadly ellipsoidal, rounded at the apex, rounded or subtruncate at the base, with 1–2(–3) transverse septa and 0–2 longitudinal or oblique septa, usually distinctly constricted at the median transverse septum, 30–45 × 18–26 (av. 36.5 × 23.5) µm, L/W = 1.3–2.1 (av. 1.6), medium brown to dark brown, densely verrucose (FIG. 1B–D).

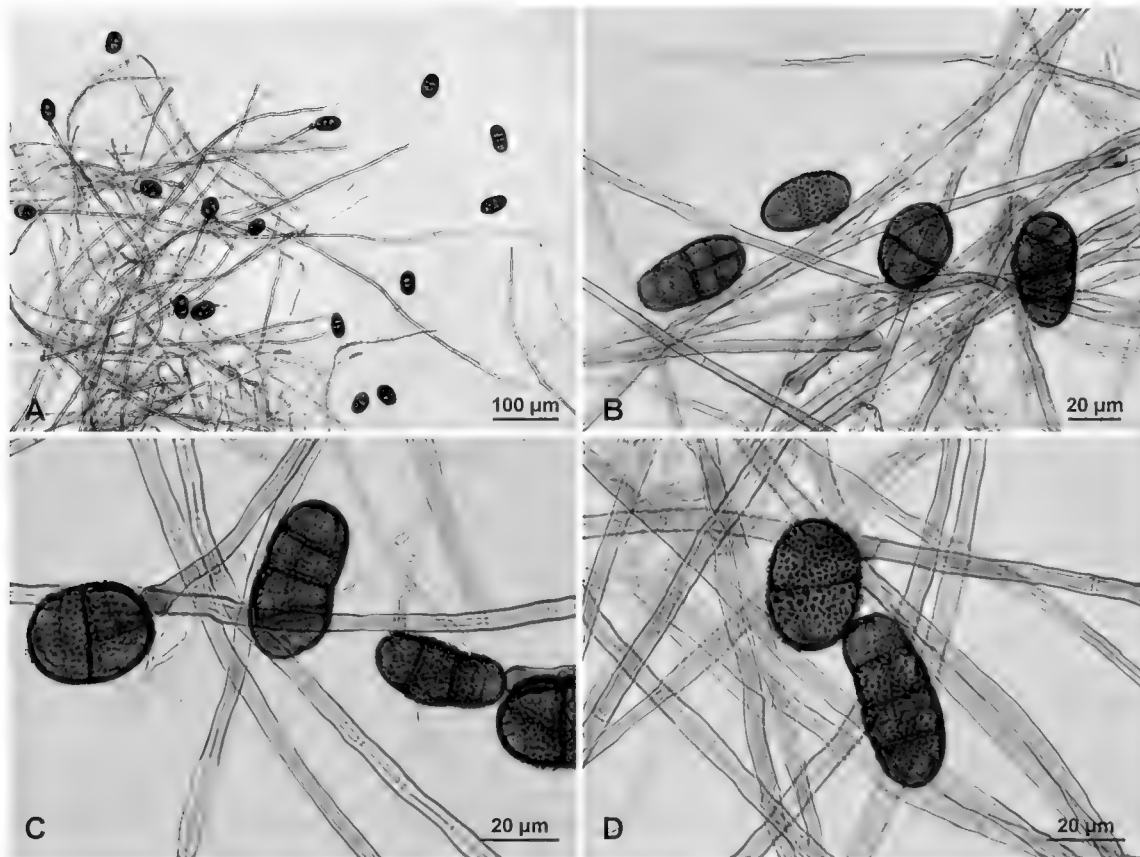


FIG. 1. *Stemphylium ixeridis*. A–C. Characteristics of mature conidia and conidiophores. D. Ornamentation of mature conidia.

The conidia of *S. ixeridis* are similar in shape to those of *S. pruni* (Wang & Zhang 2006) and *S. pyrinum* (Wang et al. 2009) (TABLE 1), but the L/W ratio is smaller. Conidia of *S. ixeridis* are usually distinctly constricted at the median transverse septum, while *S. pruni* and *S. pyrinum* are distinctly constricted at 1–2 and 1–3 transverse septa, respectively. The conidiophores of *S. ixeridis* (685–765 µm) are longer than those of *S. pruni* (87–134 µm) and *S. pyrinum* (56–110 µm). The conidial ornamentation of *S. ixeridis* is also different to that of *S. pruni* and *S. pyrinum*.

***Stemphylium brassicicola* Y.F. Pei & X.G. Zhang, sp. nov.**

FIGURE 2

MYCOBANK MB 515426

Ex culturis in agaro 'potato-carrot' descripta. Coloniae effusae, pallide brunneae vel medio-brunneae. Mycelium superficiale, hyphae ramosae, septatae, pallide brunneae, laeves, 3.5–4.5 µm latae. Conidiophora solitaria, ramosa vel nonramosa, pallide brunnea, laevia, cylindrica, 3–6-septata, 58–149 × 3.5–4.5 µm. Apex conidiogenus, medio-brunneus, usque 5.5–7.5 µm dilatatus, dense guttulatus, semel vel bis proliferens. Conidia singula in apice conidiophori, subdoliiformia, cylindrica vel oblonga cylindrica, sursum rotundata vel subtruncata, deorsum subtruncata, 1–4(–5) septis transversalibus et 3–5(–6) septis longitudinalibus vel obliquis divisa, 1–2(–3) distincte constricta, 32–45 × 12–19 µm, medio-brunnea vel brunnea, conspicue punctulata vel punctata.

HOLOTYPE: on leaves of *Brassica pekinensis* (Lour.) Rupr. (Brassicaceae), pear orchards of Korla, Sinkiang province, Northwestern China. Aug. 7. 2009, Y.F. Pei,

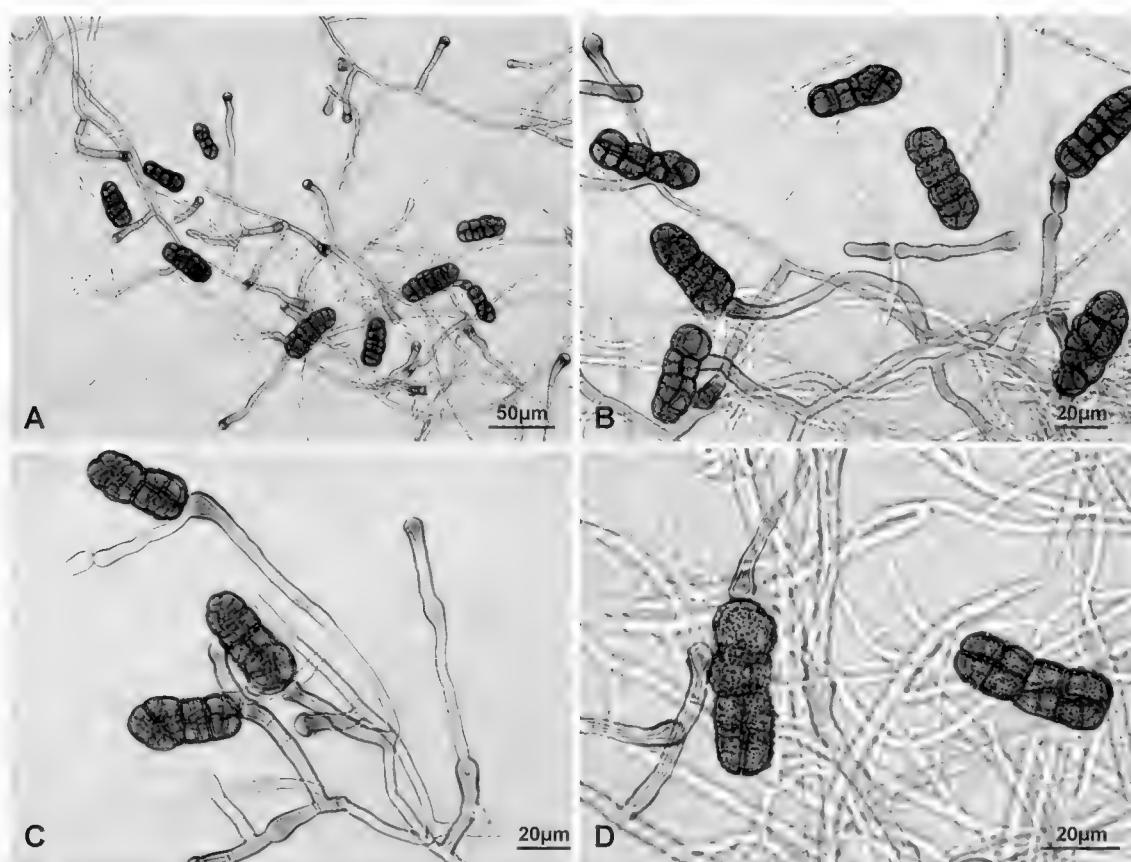


FIG. 2. *Stemphylium brassicicola*. A–C. Characteristics of mature conidia and conidiophores. D. Ornamentation of mature conidia.

HSAUPpyf1858(2), the ex-type culture is preserved in the Centraalbureau voor Schimmelcultures (CBS), No. CBS 124749.

ETYMOLOGY: in reference to the host genus, *Brassica*.

Colonies on PCA spreading, pale brown to medium brown, cottony. Mycelium superficial, hyphae branched, septate, pale brown, smooth, 3.5–4.5 µm wide. Conidiophores solitary, branched or unbranched, pale brown, smooth, cylindrical, 3–6-septate, 60–150 × 3.5–4.5 µm (FIG. 2A–C). Conidiogenous cells swollen at the apex, medium brown, 5.5–7.5 µm wide, densely guttulate, occasionally with 1–2 apical proliferations (FIG. 2B–C). Conidia developing singly, subdoliiform, cylindrical to oblong cylindrical, rounded or subtruncate at the apex, subtruncate at the base, with 1–4(–5) transverse septa and 3–5(–6) longitudinal or oblique septa, distinctly constricted at 1–2(–3) of the transverse septa, 32–45 × 12–19 (av. 36.5 × 15.0) µm, L/W = 2.0–3.1 (av. 2.4), medium brown to brown, conspicuously punctulate to punctate (FIG. 2B–D).

S. brassicicola morphologically resembles *S. bubakii* (Simmons 2002) and *S. trisectum* (Simmons 2002) (TABLE 1). However, the conidia of *S. brassicicola* are smaller with 1–2(–3) distinctly constricted transverse septa, whereas *S. bubakii* and *S. trisectum* have 8–10 and 3 distinctly constricted transverse septa, respectively. Conidia of *S. bubakii* and *S. trisectum* are verrucose whereas those of *S. brassicicola* are punctulate to punctate.

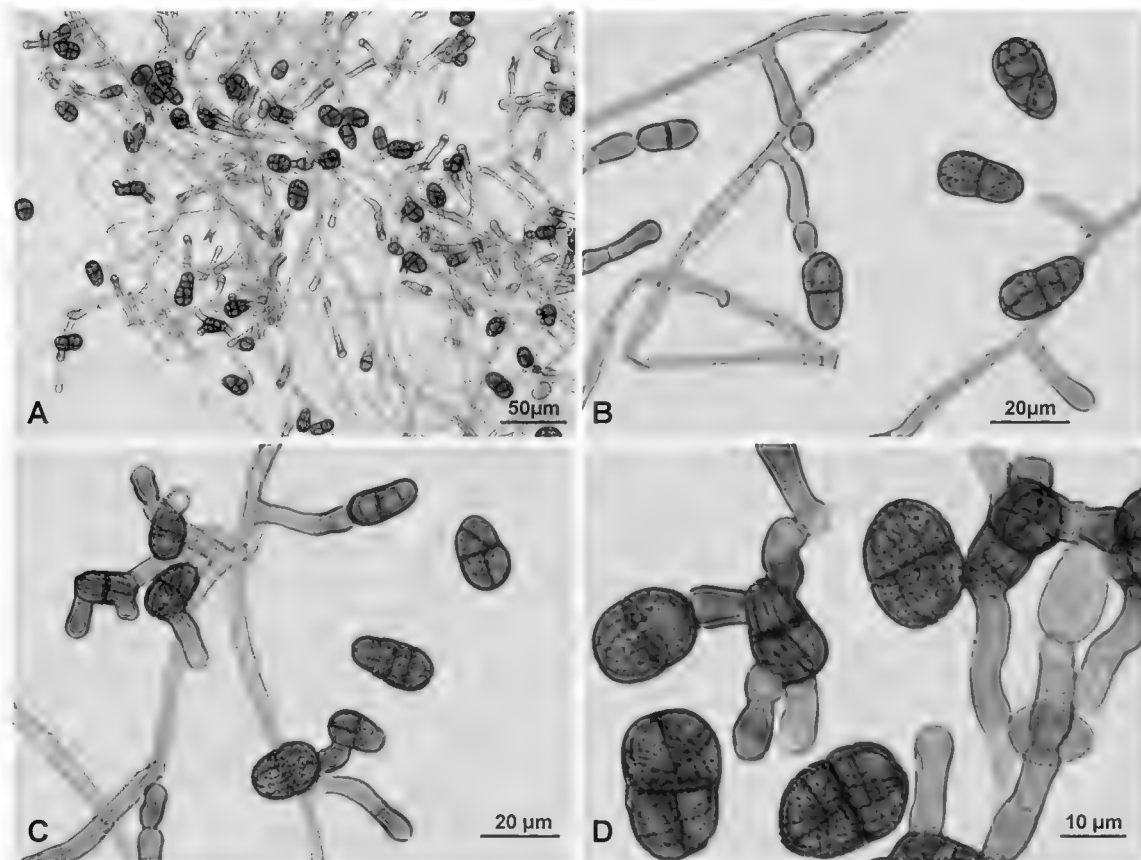


FIG. 3. *Stemphylium microsporum*. A–C. Characteristics of mature conidia and conidiophores. D. Ornamentation of mature conidia.

***Stemphylium microsporum* Y.F. Pei & X.G. Zhang, sp. nov.**

FIGURE 3

MYCOBANK MB 515427

Ex culturis in agar ‘potato-carrot’ *descripta*. *Coloniae* effusae, pallide brunneae vel medio-brunneae. *Mycelium* superficiale, *hyphae* ramosae, septatae, pallide brunneae, laeves, 3.5–4.5 μm latae. *Conidiophora* solitaria, nonramosa vel raro ramosa, pallide brunnea, laevia, cylindrica, 1–3-septata, 37–65 \times 3.5–5.5 μm . *Apex* conidiogenus, brunneus, usque 5.5–6.5 μm dilatatus, laevis, semel vel bis proliferens. *Conidia* singula in apice conidiophori, ovoidea vel oblonga ellipsoidea, sursum subtruncata, deorsum rotundata vel subtruncata, 1–2 septis transversalibus et 1–3 septis longitudinalibus vel obliquis divisa, in medio distincte constricta, 15–24 \times 9–15 μm , medio-brunnea vel brunnea, pustulata.

HOLOTYPE: on leaves of *Malus sieversii* (Ledeb.) M. Roem. (*Rosaceae*), apple orchards of Yili, Sinkiang province, Northwestern China. Aug. 10. 2009, Y.F. Pei, HSAUPpyf1904, the ex-type culture is preserved in the Centraalbureau voor Schimmelcultures (CBS), No. CBS 124753.

ETYMOLOGY: in reference to the small conidia.

Colonies on PCA spreading, pale brown to medium brown. Mycelium superficial, hyphae branched, septate, pale brown, smooth, 3.5–4.5 μm wide. Conidiophores solitary, unbranched or occasionally branched, pale brown, smooth, cylindrical, 1–3-septate, 37–65 \times 3.5–5.5 μm (FIG. 3A–C). Conidiogenous cells swollen at the apex, brown, 5.5–6.5 μm wide, smooth, occasionally with 1–2 apical proliferations (FIG. 3B–D). Conidia developing

TABLE 1. Comparison of conidial characters of *Stemphylium ixeridis*, *S. brassicicola*, *S. microsporum*, and similar *Stemphylium* species

CHARACTER	<i>S. ixeridis</i>	<i>S. pruni</i>	<i>S. pyrinum</i>	<i>S. brassicicola</i>	<i>S. bubakii</i>	<i>S. trisectum</i>	<i>S. microsporum</i>	<i>S. subglobuliferum</i>
Shape	Subspherical, ovoid, or broadly ellipsoidal	Oblong ellipsoidal or oblong	Cylindrical, ellipsoidal or oblong	Subdoliiform, cylindrical to oblong cylindrical	Broadly ovoid, broadly ellipsoidal or oblong cylindrical	Oblong	Ovoid or oblong ellipsoidal	Oblong ellipsoidal or ellipsoidal
Size (µm) (mean)	30–45 × 18–26 (36.5 × 23.5)	17–44 × 11.5–24	36–48 × 14–18 (44.1 × 15.8)	32–45 × 12–19 (36.5 × 15.0)	50–70 × 24–32	48–77 × 16–23	15–24 × 9–15 (20.0 × 12.0)	8.0–19.0 × 5.0–13.0
Transverse septa	1–2(–3)	1–3	(1–)2–3	1–4(–5)	8–10		1–2	1
Longitudinal/oblique septa	0–2	0–1	0–2	3–5(–6)	1–4		1–3	occasionally 1
Length/width ratio	1.3–2.1 (av. 1.6)	1.5–2.4 (av. 1.9)	2.0–2.8	2.0–3.1 (av. 2.4)			1.3–2.0 (av. 1.7)	1.0–2.5
Wall	Densely verrucose	Smooth	Densely tuberculate	Conspicuously punctulate to punctate	Verrucose	Verrucose	Pustulate	Smooth

singly, ovoid or oblong ellipsoidal, rounded at the apex, rounded or subtruncate at the base, with 1–2 transverse septa and 1–3 longitudinal or oblique septa, usually distinctly constricted at the median transverse septum, $15\text{--}24 \times 9\text{--}15$ (av. 20.0×12.0) μm , $L/W = 1.3\text{--}2.0$ (av. 1.7), medium brown to brown, pustulate (FIG. 3B–D).

The shape of conidia of *S. microsporum* and *S. subglobuliferum* (Xue et al. 2005) are similar (Table 1), but *S. microsporum* has larger conidia. Conidia of *S. microsporum* have more transverse and longitudinal or oblique septa than those of *S. subglobuliferum*. *S. microsporum* also differs from *S. subglobuliferum* by the ornamentation of conidial walls.

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Literature cited

- Câmara MPS, O'Neill NR, van Berkum P. 2002. Phylogeny of *Stemphylium* spp. based on ITS and glyceraldehyde-3-phosphate dehydrogenase gene sequences. *Mycologia* 94(4): 660–672.
- Simmons EG. 1967. Typification of *Alternaria*, *Stemphylium*, and *Ulocladium*. *Mycologia* 59: 67–92.
- Simmons EG. 1969. Perfect states of *Stemphylium*. *Mycologia* 61: 1–26.
- Simmons EG. 1990. *Alternaria* themes and variations (27–53). *Mycotaxon* 37: 79–119.
- Simmons EG. 2001. Perfect states of *Stemphylium* IV. *Harvard Pap. Bot.* 6(1): 199–208.
- Simmons EG. 2002. *Alternaria* themes and variations (287–304) – species on *Caryophyllaceae*. *Mycotaxon* 82: 1–40.
- Simmons EG. 2004. Novel dematiaceous hyphomycetes. *Stud. Mycol.* 50: 109–118.
- Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). *Mycotaxon* 48: 109–140.
- Wallroth FG. 1833. *Flora Cryptogamica Germaniae*, pars. post. Nürnberg: J. L. Schrag. 923 pp.
- Wang Y, Zhang XG. 2006. Three new species of *Stemphylium* from China. *Mycotaxon* 96: 77–81.
- Wang Y, Fu HB, O'Neill NR, Zhang XG. 2009. Two new species of *Stemphylium* from Northwest China. *Mycol. Prog.* 8: 289–292.
- Weber GF. 1930. Gray leaf spot of tomato caused by *Stemphylium solani* sp. nov. *Phytopathology* 20: 513–518.
- Wiltshire SP. 1938. The original and modern conceptions of *Stemphylium*. *Trans. Br. Mycol. Soc.* 21: 211–239.
- Xue F, Zhang XG, Wang Y, Wang HZ. 2005. Taxonomic studies of *Stemphylium* from China II. *Stemphylium subglobuliferum* sp. nov., and four new records. *Mycosystema* 24: 322–329.
- Yamamoto W. 1960. Synonymous species of *Alternaria* and *Stemphylium* in Japan. *Trans. Mycol. Soc. Japan* 2: 88–93.

Alternaria cerasidanica* sp. nov., isolated in Denmark from drupes of *Prunus avium

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Abstract — The ex-type strain of *Alternaria cerasidanica* was isolated in 2001 from an immature, asymptomatic drupe of *Prunus avium* collected at a commercial cherry orchard near Skælskør, Denmark. Cultural morphology, sporulation pattern and cluster analyses of combined RAPD, RAMS (microsatellite), and AFLP fingerprints of *A. cerasidanica* and 167 strains of *Alternaria* spp. support the placement of *A. cerasidanica* within the *A. infectoria* species-group sensu Simmons and its segregation from other members of this group. *A. cerasidanica* is currently monotypic and known only from preharvest sweet cherry fruit in Denmark.

Key words — hyphomycetes

Introduction

During studies of fungal colonization of drupes of *Prunus avium* (L.) L. (sweet cherry) Dugan & Roberts (1994) consistently isolated *Alternaria* strains from gynoecial scar tissues on immature cherry fruit collected at several locations in Washington State. Many of these isolates were subsequently characterized according to their sporulation pattern observable at 50× and by cluster analysis of RAPD amplicons (Roberts et al. 2000). Notable amongst the hundred of *Alternaria* isolates so obtained was the complete absence of isolates exhibiting cultural and morphological characters of *A. infectoria* species-group. A subsequent opportunity to examine cherry fruit from a geographically isolated (from Washington state) cherry orchard in Denmark was taken to determine if the absence of *A. infectoria* species-group isolates was also characteristic of Danish populations of *Alternaria* associated with developing cherry fruit.

Materials and methods

Conditions of isolation, culture and observation

During June–July 2001, RGR and BA harvested immature sweet cherry fruit (cv. Van) from a commercial orchard near Skælskør, Denmark. Harvested cherry fruit were processed by methods previously described (Roberts & Dugan 1994); they were transported on ice to DTU (Lyngby), surface disinfested with sodium hypochlorite, then the style and sepal scar tissues were aseptically excised and plated onto PCA. One hundred and four representative isolates were preserved as lyophilized conidial suspensions held at -20°C or as colonized agar blocks held in sterilized distilled water at 4°C . The media, methods and conditions for growth and observation of the resulting *Alternaria* isolates followed Simmons & Roberts (1993). Approximately 100 isolates of *Alternaria* were obtained and characterized by the pattern of sporulation evident at $50\times$ magnification with a dissecting microscope. RGR 01.0149 was among the isolates that exhibited the diagnostic sporulation patterns and cultural characters of the *A. infectoria* species-group. To observe and record microscopic characters double-stick tape was pressed onto colony surfaces and then mounted spore-side-up in several drops of lactic acid on a microscope slide for observation at higher magnifications. Microscopic morphology was observed at $200\text{--}630\times$ and recorded digitally using a Zeiss Axiocam MRc5 camera and a Zeiss Axioplan microscope. Color references in the taxonomic descriptions follow the Methuen Handbook of Colour (Kornerup & Wanscher 1989).

Molecular analysis

Selected cultures were grown, DNA was isolated and prepared, and combined fingerprints from randomly amplified polymorphic DNA (RAPD), randomly amplified microsatellites (RAMS) and amplified fragment length polymorphism (AFLP) analyses were generated and analyzed by methods reported previously (Roberts et al. 2000, Roberts 2007). The band-based fingerprint data from the Danish *A. infectoria*-group isolates were added to an existing database of molecular characters in BioNumerics 5.10 (Applied Maths, Ghent, Belgium), then analyzed by cluster analysis using the 'Similarity' and 'Average From Experiments' settings.

Taxonomic description

Alternaria cerasidanica R.G. Roberts, sp. nov.

FIG. 1

MYCOBANK MB 513487

Ex cultura in agaro PCA post 7 dies, temperatura 21 C descripta. Coloniae ca. 59 mm diam., griseobrunneae, indistincte concentricae zonatae. Conidiophora primaria simplicia vel ramosa, geniculata, $40\text{--}167 \times 3.7\text{--}7.0\ \mu\text{m}$. Conidia 4–5 (vel num. minor quam 10) catenata, subglobosa vel ellipsoidea vel subcylindrica, erostrata (vel obclavata, pseudorostrata in catenis), $23\text{--}70 \times 11\text{--}25\ \mu\text{m}$, transverse 2–8 euseptata, 0–4 longiseptata, conidiophoris secundariis apicalibus et lateralibus $5.8\text{--}86.7 \times 3.6\text{--}7.0\ \mu\text{m}$. Conidia laevia vel plerumque punctulata vel verrucosa vel tuberculata, olivaceobrunnea, septis atrobrunneis. Teleomorphosis ignota.

TYPE (holotype): BPI 878241; (dried PCA culture preparation ex RGR 01.0149), isol. RG Roberts from an immature drupe of *Prunus avium*, June 2001, Skælskør, Denmark.



FIGURE 1. Conidia and conidiophores of *A. cerasidanica* from a 7-day-old PCA culture.
Bar = 50 μ m.

Ex-type culture deposited at Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands as CBS 121923.

ETYMOLOGY: *cerasus* + *danica* – cherry fruit in Denmark as source of isolate

Description from cultures grown on PCA for 2–7 days at 25 C, 21% RH, and an 8-hour photoperiod. Colonies at 4 days ca 45 mm diam., azonate, with an even, granular appearance, centrally golden brown near 5B-DF6 with hyaline, asporogenous margins ca 8mm wide. Colonies at 7 days ca 59 mm diam., grayish brown near 6F3, indistinctly zonate, with a low, even turf of pigmented (olive, near 3D4-3E4 by transmitted light), funiculose sporogenous hyphal elements from which simple or branched primary conidiophores develop. Colony

zonations produced during light exposure result from primary conidiophores produced from the agar surface as well as aerial hyphae. Conidia are present without colony scarification, but sporulation density is greatly increased after scarification. Primary conidiophores $40.0\text{--}167.0 \times 3.7\text{--}7.0 \mu\text{m}$, pale to light grey (1B1-1D1) by transmitted light, branched or unbranched, often becoming geniculate from successive production of conidia, developing as lateral outgrowths from pigmented, funiculose aerial hyphae or from hyphae embedded within the agar medium. At $50\times$, conidia appear ellipsoidal to lenticular, robust, dark (opaque), in sparingly branched chains. Conidia developing in chains of less than 10 conidia, commonly four to five conidia per chain. Conidia $23.0\text{--}70.0 \times 11.0\text{--}25.0 \mu\text{m}$, erostrate, becoming pseudorostrate with chain formation, subglobose to ellipsoidal when young, occasionally becoming obclavate as the upper spore body elongates into a secondary conidiophore. Spore bodies may appear smooth in median optical section, but are usually ornamented, from punctulate to verrucose to coarsely tuberculate, especially on the proximal third of the spore body. Spore bodies near olive brown (4E4) by transmitted light. Secondary conidial chains produced by sympodial development of apical or lateral, short to elongate, geniculate, usually unbranched secondary conidiophores $5.8\text{--}86.7 \times 3.6\text{--}7.0 \mu\text{m}$, pigmented as primary conidiophores, frequently with an enlarged apex. Basal conidia are frequently long ellipsoidal to subcylindrical, in maturity with 2–8 darkly pigmented transsepta and 0–4 longisepta, which may be as dark as the transverse eusepta or less conspicuously pigmented. Neither ascomata nor ascospores were observed in culture or on agar blocks held in refrigerated water. After two days of growth, the appearance of the field at $50\times$ is dominated by the large, solitary broadly ellipsoidal to ovoid conidia. By day 4, short chains of 3–4 conidia can be seen but robust, solitary ellipsoidal conidia still predominate. *A. cerasidanica* is known only from the ex-type culture.

Discussion

Although *A. cerasidanica* is newly described here, the key to species within the *A. infectoria* species-group of Simmons (2007) is still useful to narrow the possible choices and thus differentiate it from the other species accepted by Simmons. As Simmons' key to the group does not resolve *A. photistica* and *A. cerasidanica*, the ex-type cultures of *A. photistica* (EGS 35.172) and *A. cerasidanica* (RGR 01.0149) were compared. Several of the agar blocks stored in water from which *A. photistica* was recovered bore senescent pseudothecia and viable ascospores of *Lewia photistica* E.G. Simmons 1986, but no intact asci were observed, confirming Simmons' observation and note on the culture (Simmons 2007). As noted previously, similarly stored agar blocks from which *A. cerasidanica* was recovered did not bear evidence of a teleomorphic state.

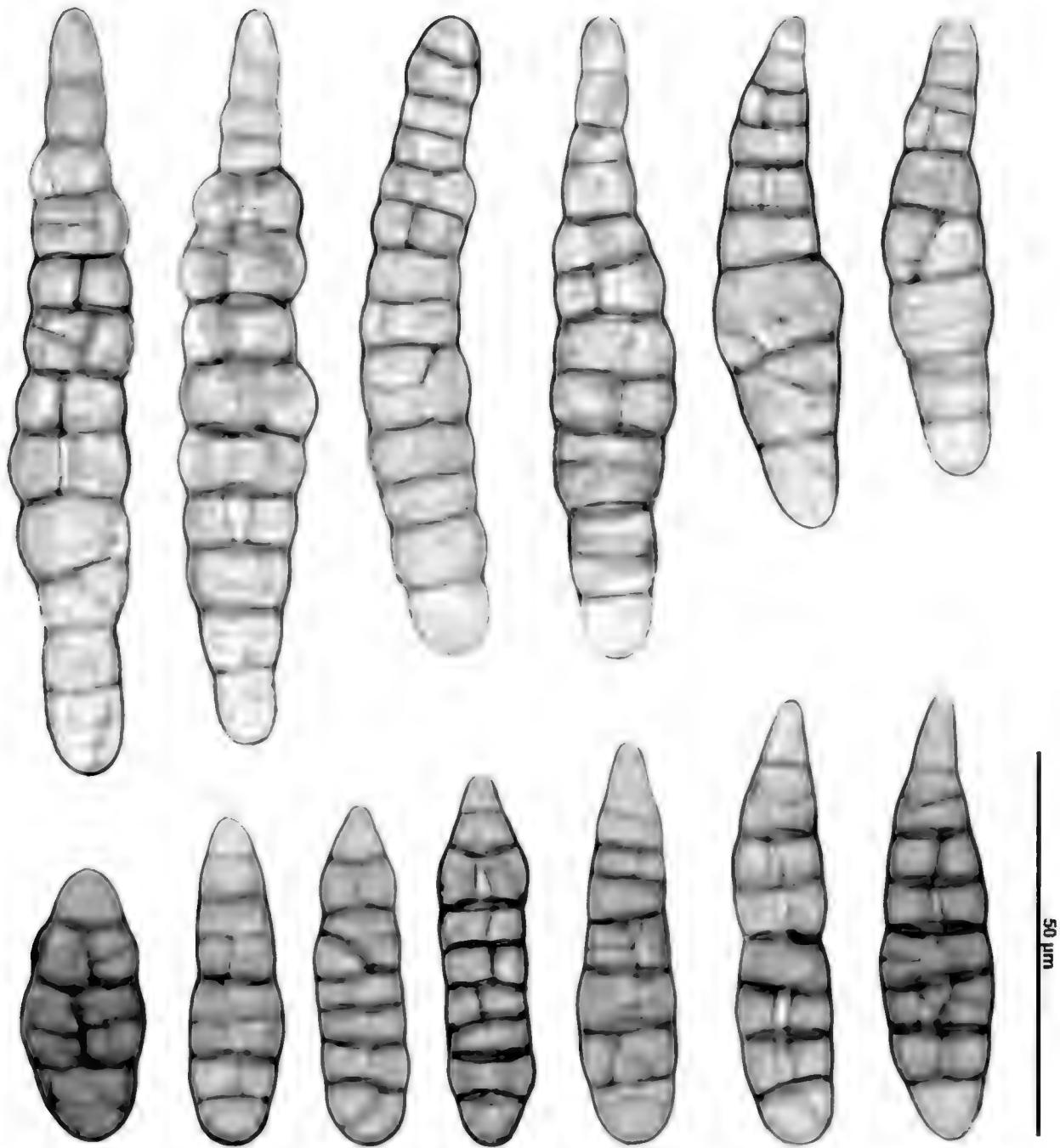


FIGURE 2. First-formed conidia from 2-day-old PCA cultures of *A. photistica* (EGS 35.172, above) and *A. cerasidanica* (RGR 01.0149, below).
Bar = 50 μm .

The largest conidia of *A. photistica* observed under our growth conditions were seen after two days growth on the agar block after transfer from the water storage tube to PCA. The largest of these first-borne conidia were $53\text{--}108 \times 13\text{--}21 \mu\text{m}$ (FIG. 2) and were considerably larger than 50 μm given in the type description (Simmons 1986b). Conidia produced thereafter were smaller, $31\text{--}56(\text{--}72) \times 11\text{--}18 \mu\text{m}$ (FIG. 3).

The reader is initially directed to Section K (in Simmons 2007: 586) as the conidia of *A. cerasidanica* occur in branching chains and develop conspicuous

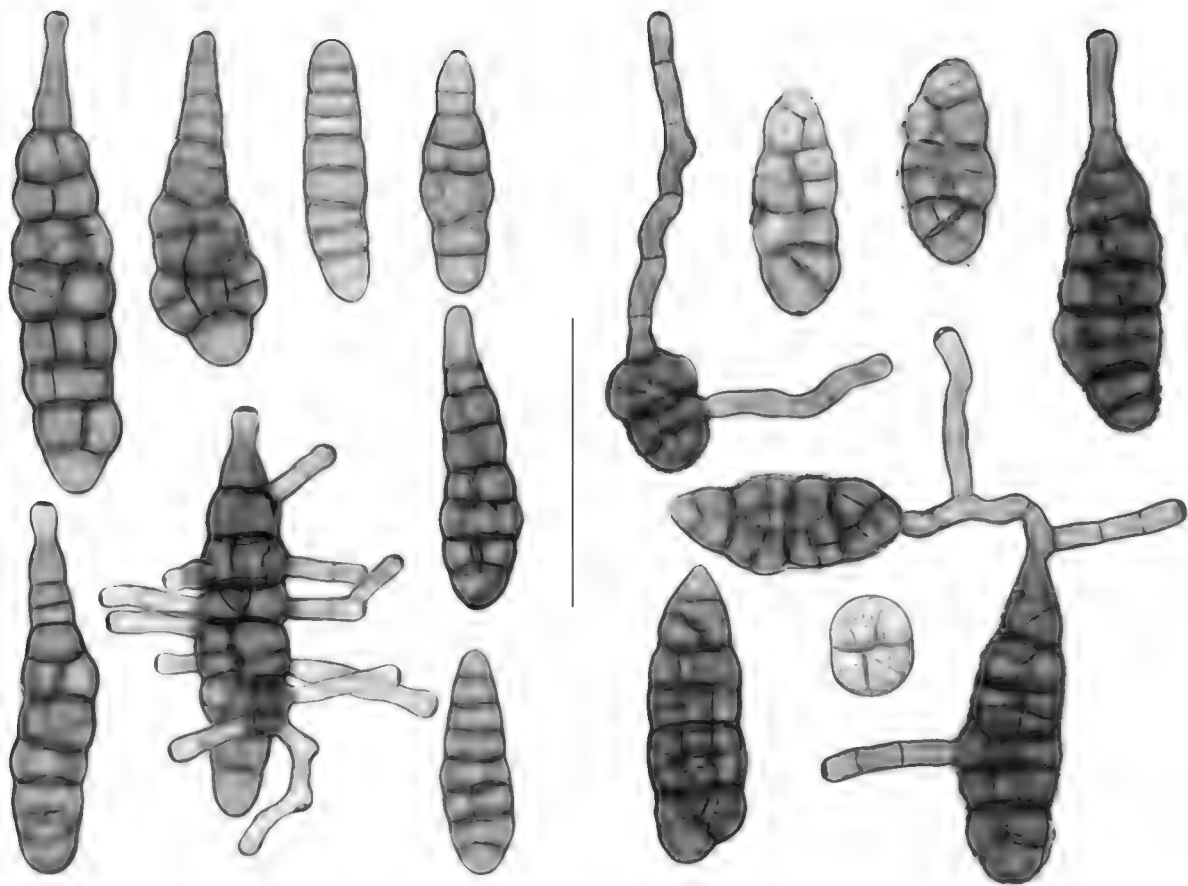


FIGURE 3. Conidia from 14-day-old PCA cultures of *A. photistica* (left of bar) and *A. cerasidanica* (right of bar).
Bar = 50 µm.

secondary conidiophores that determine in part the spatial characteristics of the sporulation apparatus. Young cultures, although sporogenous, tend to be dominated by aerial funiculose hyphae that are sparingly conidial compared to the densely packed lawn of conidiophores and conidia that develop within 24 h after colony scarification. The characters of *A. cerasidanica* that lead one through the choices in this Section are 1) conidia are ovoid to ellipsoid (to choice 4), 2) conidium color is stable in liquid mounts (to choice 5), 3) seta-like or arborescent elements are lacking (to choice 7), conidium length to max. 70–160 µm (to choice 8), and conidium width max. to range 15–20(–25) µm (to choice 9). At choice 9, *A. cerasidanica* is excluded from both *A. avenicola* and *A. triticolica* by virtue of the smaller size of the largest conidia.

Conidial size ranges overlap for *A. photistica* and *A. cerasidanica*, but in freshly prepared lactic acid mounts these species differ in conidium color, septation, shape, and ornamentation. By transmitted light *A. photistica* conidia and conidial septa are relatively pale and straw-colored (straw yellow (3B4) to grayish orange (5B3)) whereas conidia of *A. cerasidanica* are darker, approaching olive brown (4E4) and more coarsely ornamented, becoming coarsely punctate

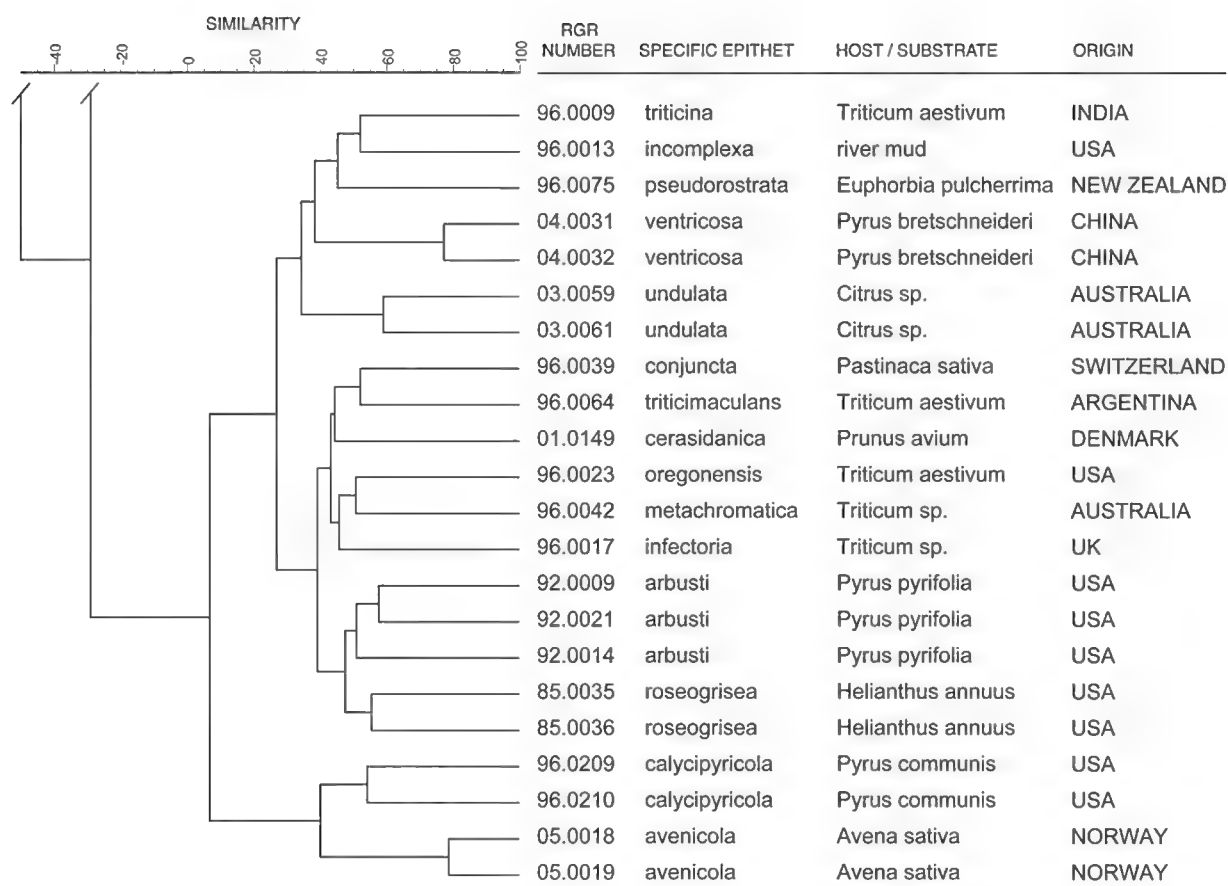


FIGURE 4. The *A. infectoria* species-group cluster excerpted from a cluster analysis of a combined RAPD, RAMS and AFLP fingerprint data set for each of 167 isolates of *Alternaria* spp. from various hosts, substrates, geographic origin, and sporulation pattern groups.

in age. Conidial septa of *A. photistica* are relatively undifferentiated, remain unthickened and lightly pigmented well into development, and regularly constrict the outline of the conidia. Conidial cross-septa in *A. cerasidanica* are precociously and darkly pigmented at two days growth, appearing thickened and nearly opaque in maturity (FIG. 2), almost embellisioid. The distal spore bodies of *A. photistica* often gradually taper to a blunt, rounded apex of 2–4 cells that is usually abruptly narrower than the proximal spore body. The distal ends of conidia from *A. cerasidanica* taper abruptly to a pyramid-shaped apex, which usually involves only one or two cells. With age, the largest conidia of *A. photistica* may bristle with short secondary conidiophores, but similar development is not observed with *A. cerasidanica* (FIG. 3). Conidial walls of *A. photistica* appear translucent with no or finely granulate ornamentation, whereas those of *A. cerasidanica* become coarsely punctate and darkly pigmented in age (FIG. 3).

An excerpt from a band-based cluster analysis of combined RAPD, RAMS and AFLP fingerprints presented in FIG. 4 provides supporting molecular evidence for the morphologically-based assignment of *A. cerasidanica* to the *A. infectoria* species-group and supports its segregation from the other included

species in our *Alternaria* database. All *Alternaria* isolates in the present study previously assigned to the *infectoria* species-group and the anamorphic states of *Lewia* clustered together in this branch.

Isolation of several *infectoria* species-group strains from Danish cherry fruits in this study is notable, as Dugan & Roberts (1994) reported no *infectoria* species-group isolates from among many hundreds of *Alternaria* strains isolated from thousands of pre-harvest cherry fruit in Washington State. Eight of the 104 isolates obtained from Danish cherry fruit belong in the *infectoria* species-group based upon cultural morphology and sporulation pattern observed at 50×, a statistic made relevant by their aforementioned absence from cherry fruit sampled in Washington State. The seven remaining *infectoria* species-group isolates from Danish cherry include several other undescribed taxa not treated here.

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Literature cited

- Dugan FM, Roberts RG. 1994. Etiology of preharvest colonization of Bing cherry fruit by fungi. *Phytopath.* 84: 1031–1036.
- Dugan FM, Roberts RG, Hanlin RT. 1995. New and rare fungi from cherry fruits. *Mycologia* 87: 713–718.
- Dugan FM, Roberts RG. 1997. Preharvest fungal colonization affects storage life of Bing cherry fruit. *J. Phytopath.* 145: 225–230.
- Kornerup A, Wanscher JH. 1989. *Methuen handbook of colour*, 3rd ed. Methuen: London (UK). 252 p.
- Roberts RG. 2007. Two new species of *Alternaria* from pear fruit. *Mycotaxon* 100: 159–167.
- Roberts RG, Reymond ST, Andersen B. 2000. RAPD fragment pattern analysis and morphological segregation of small-spored *Alternaria* species and species-groups. *Mycol. Res.* 104: 151–160.
- Roberts RG, Robertson JA, Hanlin RT. 1986. Fungi occurring in the achenes of sunflower (*Helianthus annuus*). *Can. J. Bot.* 64: 1964–1971.
- Simmons EG. 1986a. *Alternaria* themes and variations (17–21). *Mycotaxon* 25: 203–216.
- Simmons EG. 1986b. *Alternaria* themes and variations (22–26). *Mycotaxon* 25: 287–308.
- Simmons EG. 1996. *Alternaria* themes and variations (145–149). *Mycotaxon* 57: 391–409.
- Simmons EG, Roberts RG. 1993. *Alternaria* themes and variations (73). *Mycotaxon* 48: 109–140.
- Simmons EG. 2007. *Alternaria: an identification manual*. CBS Fungal Diversity Centre, Utrecht (The Netherlands). 775 p.

Three new phragmosporous hyphomycetes on *Ripogonum* from an 'ecological island' in New Zealand

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Abstract — *Corynespora ripogoni* sp. nov., *Ellisembia maungatautari* sp. nov., and *Solicorynespora maungatautari* sp. nov., found on dead stems of *Ripogonum scandens* in New Zealand, are illustrated and described, and compared with related taxa. Two other hyphomycetes are recorded from New Zealand for the first time.

Key words — anamorphic fungi, deuteromycetes, *Ellisembia bambusicola*, *Sporidesmiella parva*, taxonomy

Introduction

Maungatautari Ecological Island is a mainland conservation 'island' in central North Island, New Zealand. It is surrounded by 47 km of pest-proof fence, which was completed in August 2006. Except for a few isolated mice, all mammalian pests within the fence have been eradicated. The first of several threatened species of bird have been re-introduced to the area. During a visit to a small part of the reserve some dead stems of the liana, *Ripogonum scandens* J.R. Forst. & G. Forst. (*Smilacaceae*), were collected. Several phragmosporous species of hyphomycetes were identified from the stems, including three new species that are described below.

Materials and methods

Dead stems of *Ripogonum scandens* were collected from a forested area in the Maungatautari Ecological Island. The stems were incubated under humid conditions and periodically examined for sporulating microfungi. Fungal fruiting structures were removed, mounted in lactophenol or water, and examined by light microscopy. Measurements were made on material mounted in lactophenol. Dried herbarium specimens of the fungi were prepared and deposited in the New Zealand Fungal Herbarium (Herb. PDD). Some other specimens of fungi on *R. scandens* and *R. album* R. Br. (from Australia) held in Herb. PDD were also examined. All of the taxa are treated in alphabetical order by genus.

TABLE 1. Major morphological features of *Corynespora* species described since Siboe et al. (1999)

SPECIES ¹	CONIDIA			Host/ SUBSTRATUM
	Production	Morphology ²	Colour	
<i>acalyphae</i>	Solitary	Obclavate, rostrate	Pale brown to brown	85–120 × 9–11 8–16 <i>Acalypha</i> , Indonesia
<i>albiziicola</i>	Solitary	Obclavate, ellipsoid, or clavate	Pale olivaceous yellow	20–70.1 × 10–18.5 1–6 <i>Albizia</i> , India
<i>aquatica</i>	Solitary	Obclavate to cylindric	Pale brown	34–46 × 3–4.5 (1–)2(–3) Leaves, Mexico
<i>asclepiadacearum</i>	Mostly solitary	Obclavato-cylindric to cylindric	?Pale	44–192 × 10–25 Up to 26 <i>Cryptolepis</i> , India
<i>azadirachtiana</i>	Solitary or catenate	Obclavate	Pale yellow	32–303.5 × 7–21.5 1–20 <i>Azadirachta</i> , India
<i>barleriicola</i>	Solitary	Obclavate to cylindric	Olivaceous yellow	41–246 × 10–18.5 3–14 <i>Barleria</i> , India
<i>beilschmiediae</i>	Solitary	Obclavate	Pale brown to brown	52–144.5 × 8.5–11 7–19 <i>Beilschmiedia</i> , China
<i>bombacearum</i>	Solitary or catenate	Obclavato-cylindric to cylindric	Pale to mid olivaceous	26–206 × 8.5–17 Up to 15 <i>Bombax</i> , India
<i>caryotae</i>	Solitary	Obclavate-elongate	Pinkish brown	45–120 × 6–10 Up to 18 <i>Caryota</i> , Singapore
<i>cassiae</i>	Solitary	Obclavate	Pale brown to olivaceous brown	107.5–214 × 11–14 10–21 <i>Cassia</i> , China
<i>catenulata</i>	Solitary or catenate	Obclavate to obclavato- cylindric	Dark olivaceous yellow to pale olivaceous brown	27.5–225.5 × 11–19 1–24 <i>Clerodendrum</i> , India
<i>colebrookiana</i>	Solitary or catenate	Obclavate, rarely cylindric	Pale yellow	45–330 × 6–22 4–16 <i>Colebrookia</i> , India
<i>cucurbiticola</i>	Solitary or catenate	Obclavato-cylindric	Subhyaline to pale olivaceous	38.5–230 × 6.5–20 6–23 <i>Coccinia</i> , Nepal
<i>curvispora</i>	Solitary or catenate	Narrow obclavate	Straw-coloured to mid brown	40–250 × 10–12 5–10 Herbaceous stems, USA
<i>donacis</i>	Solitary	Obclavate	Olivaceous brown	45–70 × 8–12 10–14 <i>Donax</i> , China
<i>erythropsidis</i>	Solitary	Ellipsoid, doliiform to broad clavate	Pale brown to olivaceous brown	25–31 × 9–12 4 <i>Erythropsis</i> , China
<i>euryae</i>	Solitary	Obclavate	Pale brown to brown	36–67 × 6–9 5–9 <i>Eurya</i> , China
<i>fici-altissimae</i>	Solitary	Obclavate, rostrate	Dark brown	55–85 × 9–12 11–18 <i>Ficus</i> , China
<i>fici-benjaminiae</i>	Solitary	Obclavate	Pale olivaceous brown	51.5–71 × 8–11 5–10 <i>Ficus</i> , China
<i>flagellata</i>	Solitary	Obclavate, rostrate; smooth or verrucose	Dark brown	50–100 × 9–11 5–10 <i>Citrus</i> , Ghana
<i>gorakhpurensis</i>	Solitary	Obclavate to ellipsoid	Pale olivaceous yellow	21–157 × 13–20 3–13 <i>Erythrina</i> , India

<i>gracilis</i>	Solitary	Cylindric to obclavate	Olivaceous	92–138 × 5–7	10–22	<i>Piper</i> , Indonesia
<i>gymnocladi</i>	Solitary	Obclavate	Brown to dark brown	15–40 × 7–10.5	2–6	<i>Gymnocladus</i> , China
<i>hamata</i>	Solitary	Obclavate, hamatate at apex	Pale olivaceous brown	158–198 × 9–11	14–19	Dead wood, Indonesia
<i>holopteleae</i>	Solitary or catenate	Obclavato-cylindric to cylindric	Mid olivaceous	23–234 × 3.6–19.5	0–17	<i>Holoptelea</i> , India
<i>jasminicola</i>	Solitary	Obclavate	Pale olivaceous	39.5–176 × 10–21	2–18	<i>Jasminum</i> , Nepal
<i>kenyensis</i>	Solitary	Obclavate to obpyriform, +/- rostrate	subhyaline to pale brown	60–125 × 16–25	8–15	<i>Sericostachys</i> , Kenya
<i>keskaliicola</i>	Solitary or catenate	Obclavato-cylindric to cylindric	Mid olivaceous	64–164 × 16–28	Up to 17	<i>Hemidesmus</i> , India
<i>laevistipitata</i>	Solitary	Broadly ellipsoid	Red-brown	17.5–24 × 7–8	(0–)1–2 (–3)	<i>Pertusaria</i> (lichen), USA
<i>lasianthi</i>	Solitary	Obclavate, sometimes rostrate	Pale brown to dark brown	50–103.5 × 8.5–10	4–8	<i>Lasianthus</i> , China
<i>leucaenae</i>	Solitary	Obclavate, obovoid or ellipsoid	Pale yellow	16–298 × 10–19	1–28	<i>Leucaena</i> , India
<i>litseae</i>	Solitary	Obclavate	Pale brown to olivaceous brown	105–235 × 10–12	14–34	<i>Litsea</i> , China
<i>merrilliopanacis</i>	Solitary	Obclavate, rostrate	Straw coloured to brown	130–260 × 17–21	12–25	<i>Merrilliopanax</i> , China
<i>micheliae</i>	Solitary	Obclavate, rostrate	Subhyaline to brown	333–360 × 15–19	12–28	<i>Michelia</i> , China
<i>morindae-tinctoriae</i>	Solitary	Obclavate	Pale olivaceous	44–127 × 15–26.5	6–15	<i>Morinda</i> , India
<i>myrioneuronis</i>	Solitary	Obclavate	Pale brown to brown	30–46 × 6.5–8	3–4	<i>Myrioneuron</i> , China
<i>nana</i>	Solitary	Obclavate	Subhyaline to pale olivaceous brown	49.5–110 × 9–18.5	4–14	<i>Lantana</i> , India
<i>parapyrenariae</i>	Solitary	Obclavate	Pale brown to brown	70–100 × 11–14	5–9	<i>Parapyrenaria</i> , China
<i>parvispora</i>	Solitary	Ovoid	Brown	13–15 × 4.5–7.5	1–2	<i>Gynotroches</i> , Singapore
<i>pedaliacearum</i>	Solitary or catenate	Obclavato-cylindric to slightly acicular	Pale olivaceous	16–163 × 3.2–6	3–28	<i>Sesamum</i> , India
<i>phylloshureae</i>	Solitary	Obclavate	Brown	30–50 × 8–10	6–10	<i>Phyllostachys</i> , China
<i>premnigena</i>	Solitary or catenate	Obclavate to obclavato-cylindric	Subhyaline to pale yellow	52–265 × 10–15	1–19	<i>Premna</i> , India
<i>rhapidis-humilis</i>	Solitary	Obclavate, rostrate	Pale to olivaceous brown	90–130 × 6–8	12–16	<i>Rhapis</i> , China
<i>rhododendri</i>	Solitary	Obclavate to long rostrate	Pale brown to olivaceous brown	180–400 × 7.5–11	19–36	<i>Rhododendron</i> , China
<i>ripogoni</i>	Solitary	Obclavate	Brown	60–160 × 10–13.5	7–15	<i>Ripogonum</i> , New Zealand

TABLE 1, concluded.

SPECIES ¹	CONIDIA					HOST/ SUBSTRATUM
	Production	Morphology ²	Colour	Size (µm)	Septation	
<i>rosacearum</i>	Solitary or catenate	Obclavate to obclavato-cylindric	Subhyaline to pale olivaceous	26.5–269 × 9.18.5	1–18	<i>Eriobotrya</i> , India
<i>sacchari</i>	Solitary	Obclavate, rostrate; verrucose or smooth	Pale brown to olivaceous brown	80–120 × 8–9	10–14	<i>Saccharum</i> , China
<i>schleichericola</i>	Solitary or catenate	Obclavate	Pale olivaceous	22.5–66 × 3.8–8.5	1–12	<i>Schleichera</i> , India
<i>scolopiae</i>	Solitary	Obclavate	Pale brown to brown	90–150 × 10–13	8–11	<i>Scolopia</i> , China
<i>sed-acaciae</i>	Solitary	Obclavate	Pale brown to olivaceous brown	40–70 × 11–13.5	8–12	<i>Acacia</i> , China
<i>solani</i>	Solitary or catenate	Obclavate to cylindric	Olivaceous yellow	80.6–276 × 8–10	1–17	<i>Solanum</i> , India
<i>subcylindrica</i>	Catenate	Broadly ellipsoid, subcylindrical	Pale brown	18–60(–90) × 5–13	0–3(–6)	<i>Lippia</i> , Brazil
<i>supkharii</i>	Solitary	Obclavate	Pale olivaceous	22.5–142.5 × 10–17.5	2–11	<i>Phyllanthus</i> , India
<i>tanaceti</i>	Solitary	Obclavate; smooth or verruculose	Pale brown to olivaceous brown	60–104 × 12–16	7–12	<i>Tanacetum</i> , China
<i>tectonae</i>	Solitary	Obclavate, rostrate; verrucose or smooth	Pale brown to olivaceous brown	110–160 × 10–12	12–18	<i>Tectona</i> , China
<i>toonae</i>	Solitary	Obclavate, rostrate	Pale brown to dark brown	65–144 × 7–9	4–14	<i>Toona</i> , China
<i>tremicola</i>	Solitary	Obclavate to ellipsoid	Pale olivaceous	104–296 × 11–16	1–12	<i>Trema</i> , India
<i>trichoides</i>	Solitary	Obclavate-cylindric or obclavate	Pale olivaceous	29–170 × 10–15	3–14	<i>Triumfetta</i> , Nepal
<i>ulmacearum</i>	Solitary	Obclavate	Subhyaline to pale olivaceous	15–106 × 3.5–10	2–16	<i>Trema</i> , India
<i>viticola</i>	Solitary or catenate	Obclavate, cylindric to obovoid	Pale olivaceous	34–170 × 7–17.5	1–14	<i>Cayratia</i> , India
<i>ziziphae</i>	Solitary	Obclavato-cylindric, cylindric, or clavate	Mid olivaceous to straw coloured	33–215 × 10–27	Up to 15	<i>Ziziphus</i> , India

¹ All conidiophores are mononematous and non-stromatic, except for *C. asclepiadacearum* and *C. caroytae*, which are stromatic.

² All conidia are smooth, except where indicated.

Taxonomy

Corynespora

The genus *Corynespora* Güssow is characterised by distoseptate phragmoconidia that are produced through an apical pore in the terminal conidiogenous cell. The conidiogenous cell may proliferate one or more times. The conidia are usually produced singly, but in some species short chains of conidia may form. Siboe et al. (1999) provided a synoptic table of the main morphological features that distinguish 50 accepted species of *Corynespora*. Surprisingly, they omitted their own new species, *C. kenyensis* Siboe et al., from the table. Since then another 61 species have been described in the genus, including a new species, which is described below. To assist with the identification of these additional species, their morphological features are presented in TABLE 1, in a similar format to that used by Siboe et al. (1999). Twenty-three of the new species were described from India or Nepal as the cause of leaf spots on a wide variety of plants (Meenu et al. 1998, Singh et al. 2000, Jain et al. 2002, Sharma et al. 2002a,b, 2003, 2005, Dubey & Rai 2003). From the descriptions and drawings all 23 species appear to be very similar to the common cosmopolitan species, *C. cassicola* (Berk. & M.A. Curtis) C.T. Wei. *Corynespora cassicola* is well known to produce leaf spots on *Carica papaya* and *Cucumis sativus*, and on many other species of plants. A further 22 species have been described from China, principally on dead branches (e.g., Zhang & Xu 2005, Zhang et al. 2009).

Corynespora ripogoni McKenzie, sp. nov.

FIG. 1

MYCOBANK: MB 513214

Coloniae in substrato naturali pilosae, nigrae. Mycelium ex hyphis plerumque in substrato immersum, ramosis, septatis, laevibus, pallide brunneis, tenuitunicatis, 1.5–3.5 µm crassis compositum. Conidiophora macronematosa, mononematosa, erecta, recta vel flexuosa, nonramosa, plerumque 5–7-septata, brunnea, crassitunicata, laevia, 50–115 longa, 6–7 µm crassa, interdum per 1 proliferatione elongascentia. Cellulae conidiogenae monotreticae, in conidiophoris incorporatae, terminales, determinatae, cylindricae, 14–25 µm longa, 4.5–6 µm crassa. Conidia solitaria, sicca, acrogena, brunnea, apicem versus pallidiora, laevia, obclavatae, recta vel leviter flexuosa, 60–180 longa, 10–13.5 µm crassa, apicem versus ad 3–6 µm attenuata, basi truncata 3.5–4.5 µm lata, 7–15-distoseptata, ad septa saepe leniter constricta.

ETYMOLOGY: named after the host substrate, *Ripogonum*.

TYPE: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on dead stems of *Ripogonum scandens* (*Smilacaceae*), 12 November 2007, E.H.C. McKenzie (PDD 93526, holotype).

COLONIES on natural substrate hairy, black, consisting of large numbers of individual conidiophores. MYCELIUM mainly immersed in the substratum. HYPHAE branched, septate, smooth, pale brown, thin-walled, 1.5–3.5 µm diam. CONIDIOPHORES differentiated, single, erect, straight or flexuous, unbranched,

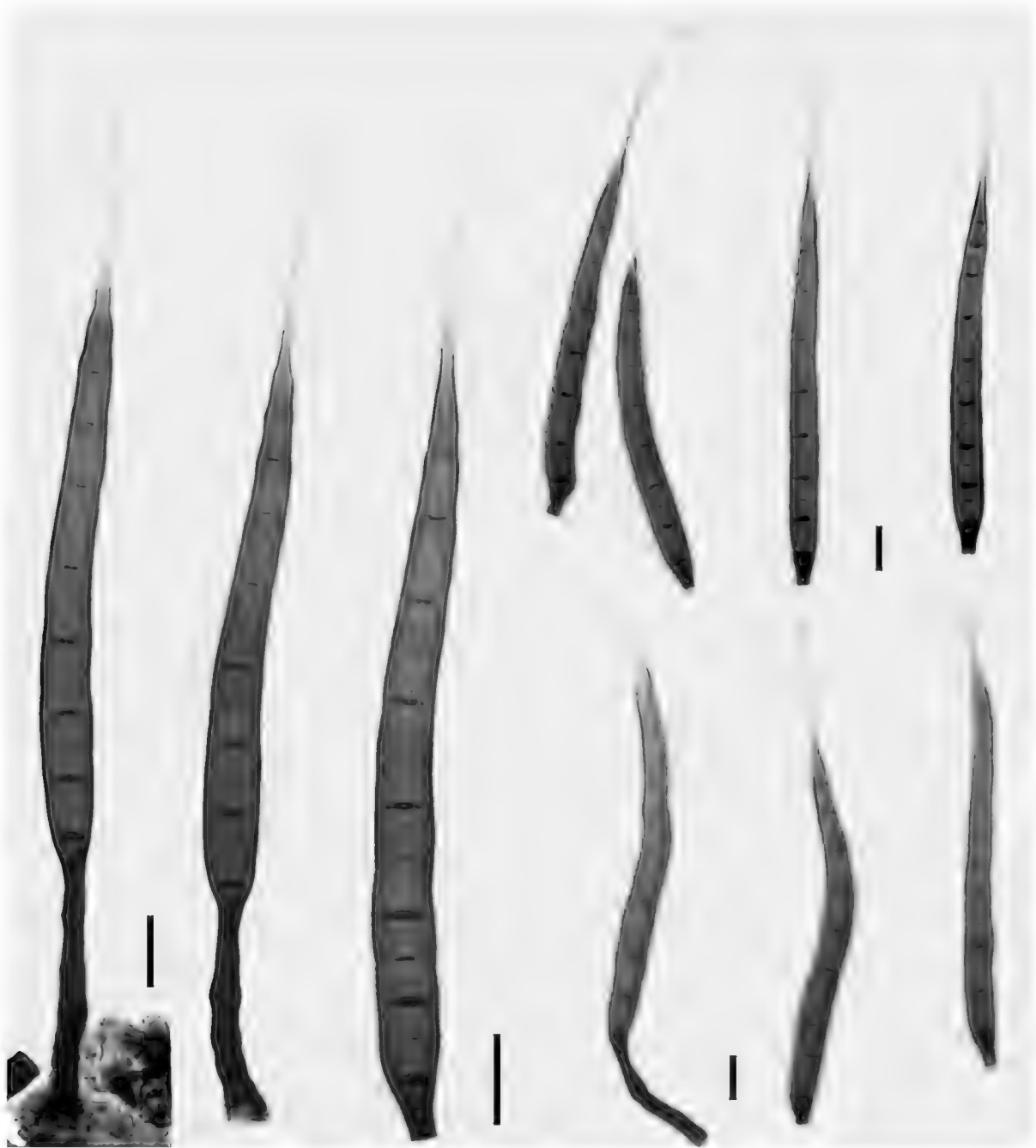


FIG. 1. Conidia and conidiogenous cells of *Corynespora ripogoni* (from holotype). Specimens mounted in hydrous lactophenol. Scale bar = 20 μ m.

mainly 5–7-septate, brown, thick-walled, smooth, 50–115 μ m long, 6–7 μ m wide above base, 4.5–6 μ m wide at apex, sometimes with 1 percurrent, enteroblastic apical proliferation. CONIDIOGENOUS CELLS monotretic, integrated, terminal, determinate, cylindrical, 14–25 μ m long, 4.5–6 μ m wide. CONIDIA solitary, dry, acrogenous, brown, paler towards the apex, smooth, obclavate, straight or slightly curved, 60–180 μ m long, 10–13.5 μ m wide in the broadest part (mean = 105.9 \times 11.5 μ m, n = 25), 3–6 μ m wide near apex, 3.5–4.5 μ m wide at the protruding truncate base, 7–15-distoseptate, often slightly constricted at some septa (particularly at second septum from base) giving a wavy outline to conidia.

COMMENTS: Several species of *Corynespora* have obclavate conidia that are similar to the conidia of *C. ripogoni* (see Ellis 1971, Siboe et al. 1999, Zhang & Xu 2005). However, *C. ripogoni* can be distinguished from other species by overall shape of the conidia, number of septa, and its conidial dimensions, in particular conidial width. It is morphologically quite distinct from *C. cassicola*.

Ellisembia

The genus *Ellisembia* Subram. is characterised by the formation of solitary, holoblastic conidia on unbranched conidiophores that may undergo percurrent proliferation. The conidia are phragmosporous, often with numerous cells, pale to dark brown or almost black (Subramanian 1992, Wu & Zhuang 2005). Many species of *Ellisembia* were formerly included in *Sporidesmium*. The conidia of *Ellisembia* are distoseptate whereas those of *Sporidesmium* are euseptate (Ellis 1958, 1971, Subramanian 1992, McKenzie 1995). However, *Sporidesmium* and morphologically similar genera, such as *Ellisembia*, are polyphyletic and distributed throughout two major ascomycete classes (Shenoy et al. 2006). The relationships of the New Zealand species are unknown. Robert et al. (2005) list 43 specific names under *Ellisembia*. The species are distinguished primarily on conidial morphology and size (Ellis 1971, Subramanian 1992, Wu & Zhuang 2005). A large-spored specimen collected on *Ripogonum scandens* in New Zealand is distinct from all other known species and is described below. In addition, two other species of *Ellisembia* were found on *R. scandens* in the Maungatautari Ecological Island.

Ellisembia adscendens (Berk.) Subram., Proc. Indian Acad. Sci. B 58 183 (1992).

= *Sporidesmium adscendens* Berk., Ann. Mag. Nat. Hist. 4: 291 (1840).

SPECIMENS EXAMINED: NEW ZEALAND, Auckland, St Heliers Bay, Dingle Dell, on *R. scandens*, 16 April 2004, E.H.C. McKenzie (PDD 80287). Waikato, near Pukeatua, Maungatautari Ecological Island, on *R. scandens*, 12 November 2007, E.H.C. McKenzie (PDD 93263). AUSTRALIA, Queensland, Bunya Mountain National Park, Westcott Plain, on *R. album*, 23 November 1995, E.H.C. McKenzie (PDD 65302).

COMMENTS: This species is widely distributed, usually on woody substrates (Ellis 1971, McKenzie 1995, Wu & Zhuang 2005). In New Zealand it is known only from the northern part of the country on both native and introduced plants.

Ellisembia bambusicola (M.B. Ellis) J. Mena & G. Delgado, in

Mena-Portales et al., Boln Soc. Micol. Madrid 25: 266 (2000).

= *Sporidesmium bambusicola* M.B. Ellis, Mycol. Pap. 70: 34 (1958).

SPECIMEN EXAMINED: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on *R. scandens*, 12 November 2007, E.H.C. McKenzie (PDD 94155).

CONIDIOPHORES brown, up to 75 µm long, 7.5 µm wide at base tapering to 4.3 µm wide near apex. CONIDIA brown, 80–110 µm long, 11.5–14 µm wide

at widest point, apex 3.5–5 µm wide, base 4.5–6 µm wide, 10–18-distoseptate, septa averaging 6.3 µm apart.

COMMENTS: The conidial dimensions of the New Zealand specimen are very similar to those given by Ellis (1958) and Wu & Zhuang (2005). Ellis (1958) described the conidia as being 11–25-distoseptate and measuring 65–125 × 11–14 µm, 3–6 µm wide at the apex, and 4–5.5 µm wide at the base. He also stated that the septa averaged 6.2 µm apart. Wu & Zhuang (2005) gave similar measurements, reporting the conidia as 12–20-distoseptate, 60–130 × 13–15 µm, 5–10 µm wide at the apex, and 4–6 µm wide at the base.

This species has not been previously recorded in New Zealand. Superficially the conidia appear similar to those of *E. maungatautari*, especially in overall shape and in the shape of the conico-truncate base. However, the conidia of *E. bambusicola* are considerably smaller and lack the long, hyaline beak. *Ellisembia bambusicola* was originally described on bamboo culms from west Africa. The teleomorph, *Miyoshiella fusispora* Kawam., was described from Japan (Réblová 1999), where it is reported to cause black spots on bamboo. The fungus is also recorded from Cuba, Mexico, USSR, India, Hong Kong, and China (Wu & Zhuang 2005, Farr et al. 2009). Most records are on members of the *Poaceae* and *Areaceae*, although there are reports of the fungus on unidentified branches and trunks (Mena-Portales et al. 2000).

***Ellisembia maungatautari* McKenzie, sp. nov.**

FIG. 2

MYCOBANK: MB 513215

Coloniae in substrato naturali pilosae, nigrae. Mycelium ex hyphis plerumque in substrato immersum. Conidiophora macronematosa, mononematosa, erecta, recta vel flexuosa, nonramosa, 0–1(–2)-septata, atro-brunnea, crassitunicata, laevia, 15–65 µm longa, 5–9 µm crassa. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae, cylindricae, 10–45 µm longa, 6–9 µm crassa. Conidia solitaria, sicca, acrogena, brunnea, plerumque rostrata, laevia vel verruculosis, cylindrica vel obclavata, recta vel leviter flexuosa, 85–125 µm longa (rostrum exclusa), 170–275 µm longa (rostrum inclusa), 13–15 µm crassa, apice acuta, ad basim conico-truncata, 5–7 µm lata, apicem versus ad 0.5–3.5 µm attenuata, 17–23-distoseptata; cellulis basalibus 1 vel 2 majoribus, atro-brunneis; cellulis apicalibus gradatim pallidioribus.

ETYMOLOGY: named after the type locality, Maungatautari Ecological Island.

TYPE: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on dead stems of *Ripogonum scandens* (*Smilacaceae*), 12 November 2007, E.H.C. McKenzie (PDD 93259).

COLONIES on natural substrate hairy, black, consisting of large numbers of individual conidiophores. MYCELIUM mainly immersed in the substratum. CONIDIOPHORES differentiated, single, erect, straight or flexuous, unbranched, 0–1(–2)-septate, dark brown, thick-walled, smooth, 15–65 µm long, sometimes of uneven width, 5–6.5 µm wide at apex, 7.5–9 µm wide at mid



FIG. 2. Conidia and conidiogenous cells of *Ellisembia maungatautari* (from holotype). Specimens mounted in hydrous lactophenol. Scale bars = 20µm.

point. CONIDIOGENOUS CELLS monoblastic, integrated, terminal, determinate, cylindrical, 10–45 µm long, 6–9 µm wide. CONIDIA solitary, dry, acrogenous, brown, 1 or 2 basal cells dark brown, usually rostrate, beak very pale brown, smooth or verruculose, cylindrical or obclavate, straight or slightly curved, 85–125 µm long (mean = 105 µm, $n = 25$) excluding the beak, 170–275 µm long (mean = 234 µm, $n = 15$) including the beak, 13–15 µm wide in the broadest part (mean = 14.0 µm, $n = 25$), 5.5–8 µm wide at apical septum, 5–7 µm wide at the conico-truncate base, 17–23-distoseptate; beak 50–80 µm long, 1.5–3.5 µm wide at base tapering to 0.5–3.5 µm wide at apex.

COMMENTS: Several species of *Sporidesmium* sensu lato have conidia with a filiform beak or appendage including *S. magnibrachypus* Matsush., *S. malayasianum* Subram., *S. ochnae* Cheng K. Shi & X.G. Zhang, *S. pruni* Jian Ma & X.G. Zhang, *S. queenslandicum* Matsush., and *S. raphidophorae* K. Zhang & X.G. Zhang. These species are compared with *E. maungatautari* (TABLE 2). *Ellisembia maungatautari* most closely resembles *S. malayasianum* in overall shape, size and colour of the conidia. However, the conidia of *S. malayasianum* are euseptate (Subramanian 1994/95), whereas those of *E. maungatautari* are distoseptate.

TABLE 2. Comparison of *Ellisemia maungatautari* with some morphologically similar species of *Sporidesmium* sensu lato.

SPECIES	CONIDIA				HOST/ SUBSTRATUM
	Septation	Morphology	Size (µm)	Base (µm)	
<i>S. magnibrachypus</i>	9–14 distoseptate	Cylindro-fusiform	48–80* × 12–15.5	3–4 (–5)	Wood, Japan
<i>S. malayasianum</i>	10–17 euseptate	Long subcylindrical to long-subobclavate	160–210 × 10–14	6–9	Palm rachis, Malaysia
<i>E. maungatautari</i>	17–23 distoseptate	Cylindrical to obclavate	170–275 × 13–15	5–7	<i>Ripogonum</i> , New Zealand
<i>S. ochnae</i>	8–11 distoseptate	Obclavate	80–110 × 10–12	4–6	<i>Ochna</i> , China
<i>S. pruni</i>	5–8 distoseptate	Fusiform	45–87 × 8.5–10.5	2–3.6	<i>Prunus</i> , China
<i>S. queenslandicum</i>	10–14 distoseptate	Subulate-cylindrical	60–84 × 7–9	ca 4	<i>Archontophoenix</i> , Australia
<i>S. raphidophorae</i>	14–17 euseptate	Obclavate	93–200 × 12–16.5	4–5.5	<i>Raphidophora</i> , China

* excluding beak, which is 60–80 µm long

Helminthosporium palmigenum Matsush., Microfungi Sol. Is. PNG: 30 (1971).

SPECIMENS EXAMINED: NEW ZEALAND, Auckland, Waitakere Ranges, Spragg Bush, on *R. scandens*, November 2007, E.H.C. McKenzie (PDD 54913); Henderson, Corban Estate, banks of Shona Stream, on *R. scandens*, 26 March 2006, E.H.C. McKenzie (PDD 77148).

COMMENTS: This species was first described from Solomon Islands on coconut palm (Matsushima 1971). Since then it has been recorded on several palm genera in Cuba, Venezuela, Taiwan, and Australia (Farr et al. 2009). Surprisingly, in New Zealand *H. palmigenum* is very common on *Ripogonum scandens*; Hughes (1978) cited seven specimens on this host. No specimen was kept from a scant collection from Maungatautari Ecological Island.

Helminthosporium velutinum Link, Ges. Naturf. Freunde Berlin Mag. 3: 10 (1809).

SPECIMENS EXAMINED: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on *R. scandens*, 12 November 2007, E.H.C. McKenzie (PDD 93261). Gisborne, Te Urewera National Park, Waikaremoana, Tawa Track, on *R. scandens*, 11 May 2001, E.H.C. McKenzie (PDD 74074, 74080). AUSTRALIA, Queensland, Bunya Mountains National Park, Westcott Plain, on *R. album*, E.H.C. McKenzie (PDD 65299).

COMMENTS: This cosmopolitan species was first recorded from New Zealand by Hughes (1978) on dead wood and bark of several species of native and introduced plants, including *Ripogonum scandens*.

Pseudospiropes simplex (Kunze) M.B. Ellis, Dematiaceous hyphomycetes: 260 (1971).

SPECIMENS EXAMINED: NEW ZEALAND, Auckland, Waitakere Ranges, Spragg Bush, on *R. scandens*, 23 May 1996, E.H.C. McKenzie (PDD 73905). Coromandel, Kauaeranga Valley, Moss Creek Hut Track, on *R. scandens*, 30 August 1986, E.H.C. McKenzie (PDD

52309). Waikato, Mt Pirongia, on *R. scandens*, 21 May 1988, E.H.C. McKenzie (PDD 65789); near Pukeatua, Maungatautari Ecological Island, on *R. scandens*, 12 November 2007, E.H.C. McKenzie (PDD 93266). Wanganui, Kai Iwi, Bushy Park, on *R. scandens*, 15 May 1987, E.H.C. McKenzie (PDD 53614).

COMMENTS: This fungus is common and widespread in New Zealand on wood and bark of a broad range of native and introduced plants (Hughes 1978). It has been recorded previously on *Ripogonum scandens* in New Zealand (Hughes 1978). It is also known from North America, Europe, Africa, and China (Ellis 1971, Shang & Zhang 2007).

Solicorynespora

The genus *Solicorynespora* R.F. Castañeda & W.B. Kendr. was erected to accommodate those *Corynespora*-like species that have euseptate rather than distoseptate conidia (Castañeda Ruíz & Kendrick 1990). While such a character probably does not provide a phylogenetic distinction, it is useful to be able to morphologically divide a relatively large genus such as *Corynespora* into smaller units. Such an approach is followed with *Ellisembia*, which is the distoseptate equivalent of *Sporidesmium*, although the complex has been shown to be polyphyletic (Shenoy et al. 2006). Castañeda Ruíz et al. (2004) provided a key to eight species of *Solicorynespora*, but inexplicably omitted the type species, *S. zapatensis* R.F. Castañeda & W.B. Kendr. and *S. garciniae* (Petch) G. Delgado & J. Mena. Recently, *Corynespora foveolata* (Pat.) S. Hughes was transferred to *Solicorynespora* (Shirouzu & Harada 2008). A new species from Maungatautari Ecological Island is described below.

Solicorynespora maungatautari McKenzie, sp. nov.

FIG. 3

MYCOBANK: MB 513216

Coloniae in substrato naturali effusae, pilosae, nigrae. Mycelium ex hyphis plerumque in substrato immersum, ramosis, septatis, laevibus, luteus vel pallide brunneis, tenuitunicatis, 1.5–2 µm crassis compositum. Conidiophora macronematosa, mononematosa, erecta, recta vel flexuosa, nonramosa, septata, atro-brunnea, apicem versus pallidiora, crassitunicata, laevia, 55–120 µm longa, 3.5–4.5 µm crassa, interdum per 1–2 proliferatione elongascentia. Cellulae conidiogenae monotreticae, in conidiophoris incorporatae, terminales, determinatae, cylindricae, 12–21 µm longa, 3.5–4.5 µm crassa. Conidia solitaria, sicca, acrogena, brunnea, laevia, obclavata vel fusiforma, recta vel leviter flexuosa, 22–41 µm longa, 4.5–6.5 µm crassa, apice acuta, ad basim conico-truncata, 2–2.5 µm lata, apicem versus ad 2–3 µm attenuata, (3–)4–5(–6)-euseptata; cellulis basalibus 2 vel 3 majoribus, brunneis; cellulis apicalibus gradatim pallidioribus.

ETYMOLOGY: named after the type locality, Maungatautari Ecological Island.

TYPE: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on dead stems of *Ripogonum scandens* (*Smilacaceae*), 12 November 2007, E.H.C. McKenzie (PDD 93262, holotype).

COLONIES on natural substrate effuse, hairy, black, covering large areas of stem. MYCELIUM mainly immersed in the substratum. HYPHAE branched,



FIG. 3. Conidia and conidiogenous cells of *Solicorynespora maungatautari* (from holotype). Specimens mounted in hydrous lactophenol. Scale bar = 20µm.

septate, smooth, yellowish to pale brown, thin-walled, 1.5–2 µm diam. CONIDIOPHORES differentiated, single, erect, straight or flexuous, unbranched, septate, dark brown, paler towards apex, thick-walled, smooth, 55–120 µm long, 3.5–4.5 µm wide near base, sometimes with 1–2 percurrent, enteroblastic, apical proliferations. CONIDIOGENOUS CELLS monotretic, integrated, terminal, determinate, cylindrical, 12–21 µm long, 3.5–4.5 µm wide. CONIDIA solitary, dry, acrogenous, lower 2 or 3 cells brown, other cells paler, smooth, obclavate to fusiform, gradually tapered to an obtuse apex, more abruptly tapered to a protruding truncate base, straight or slightly curved, 22–41 µm long, 4.5–6.5 µm wide in the broadest part (mean = 30.2×5.9 µm, $n = 25$), 2–2.5 µm wide at the base, 2–3 µm wide near apex, (3–)4–5(–6)-euseptate.

COMMENTS: *Solicorynespora maungatautari* is morphologically most similar to *S. mulanjeensis* (B. Sutton) R.F. Castañeda et al., although conidia of the latter species are much larger ($56\text{--}71 \times 10\text{--}12.5$ µm) with more septa (5–8-euseptate).

Sporidesmiella parva (M.B. Ellis) P.M. Kirk, Trans. Br. Mycol. Soc.

79: 486 (1982) var. *parva*.

≡ *Endophragmia parva* M.B. Ellis, More dematiaceous hyphomycetes: 138 (1976).

SPECIMEN EXAMINED: NEW ZEALAND, Waikato, near Pukeatua, Maungatautari Ecological Island, on *R. scandens*, 12 November 2007, E.H.C. McKenzie (PDD 93260).

CONIDIOPHORES 85–150 µm long, swollen at base up to 9 µm wide, 3.5–4 µm wide above the base tapering to 2.5–3 µm at the apex. CONIDIA 16.5–20.5 × 3–5.5 µm, 1-distoseptate.

COMMENTS: Ellis (1976) described the conidia of *S. parva* as being 1–2-distoseptate and measuring 15–18 × 3–4 µm. Kirk (1982) gave slightly broader conidial dimensions of (12–)13–18.5(–20) × 2.5–4 µm and said the conidia were 1(–2)-distoseptate. In his illustration Kirk drew only one conidium with two septa. When mounted in lactophenol, conidia from the New Zealand specimen appeared to be more than 1-distoseptate; however, in water they were all obviously 1-distoseptate. Wu & Zhuang (2005) recorded conidia from Chinese collections as 16–20 × 2.5–3 µm and 1–2-distoseptate. *Sporidesmiella parva* has been recorded on a range of host plants from various parts of the world including Cuba, UK, USSR, Malaysia, China, and Japan (Wu & Zhuang 2005). This is the first record of this species from New Zealand.

Acknowledgments

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Literature cited

- Castañeda Ruíz RF, Heredia GP, Arias RM, Saikawa M, Minter DW, Stadler M, Guarro J, Decock C. 2004. Two new hyphomycetes from rainforests of México, and *Briansuttonia*, a new genus to accommodate *Corynespora alternarioides*. *Mycotaxon* 89: 297–305.
- Castañeda Ruíz RF, Kendrick WB. 1990. Conidial fungi from Cuba: II. University of Waterloo Biology Series 33: 1–61.
- Dubey RK, Rai AN. 2003. Two new hyphomycetous fungi from India. *Indian Phytopathology* 56: 486–490.
- Ellis MB. 1958. *Clasterosporium* and some allied dematiaceae-phragmosporae. I. *Mycological Papers* 70: 1–89.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, U.K. 608 pp.
- Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Kew, U.K. 507 pp.
- Farr DF, Rossman AY, Palm ME, McCray EB. 2009. Fungal databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. Retrieved 12 October 2009, from <http://nt.ars-grin.gov/fungal-databases/>
- Hughes SJ. 1978. New Zealand fungi 25. Miscellaneous species. *New Zealand Journal of Botany* 16: 311–370.
- Jain SL, Rai AN, Mehta P. 2002. Additions to the genus *Corynespora* from India. *Indian Phytopathology* 55: 51–56.
- Kirk PM. 1982. New or interesting microfungi. VI. *Sporidesmiella* gen.nov. (hyphomycetes). *Transactions of the British Mycological Society* 79: 479–489.

- Matsushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. Published by the author, Kobe, Japan.
- McKenzie EHC. 1995. Dematiaceous hyphomycetes on *Pandanaceae*. 5. *Sporidesmium* sensu lato. Mycotaxon 56: 9–29.
- Meenu, Kharwar RN, Bhartiya HD. 1998. Some new forms of genus *Corynespora* from Kathmandu valley of Nepal. Indian Phytopathology 51: 146–151.
- Mena-Portales J, Delgado-Rodríguez G, Heredia-Abarca G. 2000. Nuevas combinaciones para especies de *Sporidesmium* sens. lat. Boletín de la Sociedad Micológica de Madrid 25: 265–269.
- Réblová M. 1999. Studies in *Chaetosphaeria* sensu lato III. *Umbrinosphaeria* gen. nov. and *Miyoshiella* with *Sporidesmium* anamorphs. Mycotaxon 71: 13–43.
- Robert V, Stegehuis G, Stalpers J. 2005. The MycoBank engine and related databases. Retrieved 12 October 2009, from <http://www.mycobank.org>
- Shang Z-Q, Zhang X-G. 2007. Taxonomic studies of *Pseudospiropes* from Yunnan, China. Mycotaxon 100: 149–153.
- Sharma N, Chaudhary S, Kamal. 2002a. Three new species of genus *Corynespora*. Indian Phytopathology 55: 178–181.
- Sharma N, Chaudhary RK, Kamal. 2002b. Five undescribed species of *Corynespora*. Indian Phytopathology 55: 458–463.
- Sharma N, Singh PN, Kamal. 2003. Three new taxa of *Corynespora* causing foliar blight in forest plants of north eastern Uttar Pradesh. Journal of Mycology and Plant Pathology 33: 26–32.
- Sharma N, Soni KK, Jamaluddin, Verma RK. 2005. A new species of *Corynespora* from central India. Indian Phytopathology 58: 503–504.
- Shenoy BD, Jeewon R, Wu WP, Bhat DJ, Hyde KD. 2006. Ribosomal and RPB2 DNA sequence analyses suggest that *Sporidesmium* and morphologically similar genera are polyphyletic. Mycological Research 110: 916–928.
- Shirouzu T, Harada Y. 2008. Lignicolous dematiaceous hyphomycetes in Japan: five new records for Japanese mycoflora, and proposals of a new name, *Helminthosporium magnisporum*, and a new combination, *Solicorynespora foveolata*. Mycoscience 49: 126–131.
- Siboe GM, Kirk PM, Cannon PF. 1999. New dematiaceous hyphomycetes from Kenyan rare plants. Mycotaxon 73: 283–302.
- Singh A, Singh SK, Kamal. 2000. Three new species of *Corynespora* from India. Journal of Mycology and Plant Pathology 30: 44–49.
- Subramanian CV. 1992. A reassessment of *Sporidesmium* (hyphomycetes) and some related taxa. Proceedings of the Indian National Science Academy B 58: 179–190.
- Subramanian CV. 1994/95. Hyphomycetes from south east Asia—novelties from Singapore and Malaysia. Kavaka 22/23: 52–76.
- Wu W, Zhuang W. 2005. *Sporidesmium*, *Endophragmiella* and related genera from China. Fungal Diversity Research Series 15. 351 pp.
- Zhang K, Fu H-B, Zhang X-G. 2009. Taxonomic studies of *Corynespora* from Hainan, China. Mycotaxon 109: 85–93.
- Zhang X-G, Xu J-J. 2005. Taxonomic studies of *Corynespora* from Guangxi, China. Mycotaxon 92: 431–436.

***Elotespora*, an enigmatic anamorphic fungus from Tabasco, Mexico**

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Abstract — *Elotespora mexicana* anam. gen. & sp. nov., found on decaying wood of an unidentified plant, is described and illustrated. It is distinguished by minute, scattered, cupulate conidiomata in which a single, large, muriform, elongate ellipsoid to cylindrical brown conidium is produced. The conidial development of this fungus is unclear.

Key words — tropical rainforest, systematics, conidial fungi

Introduction

During an expedition in 2003 through the protected areas of Tabasco State, Mexico, several interesting and uncommon microfungi were encountered. A conspicuous and enigmatic fungus, collected on decaying wood, is the topic of the present paper.

NOTE — MYCOTAXON prepared this PDF with color plates for the author. The original print version was published with halftone (grayscale) plates.

Materials and methods

Individual collections were placed in paper bags and taken to the laboratory incubated at 25° C in Petri dishes placed in a moist chamber composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of $\times 1000$. Micrographs were obtained with a Zeiss Axioskop 40 microscope, Leitz Dialux 20 EB microscope and a Jeol JSM-6400 scanning electron microscope using the techniques described previously by Figueras & Guarro (1988). The fungus was isolated into pure culture by placing conidia on the surface of corn meal agar plus carrot extract (Castañeda et al. 2005).

Results

Sterile hyphae grew in culture but after two weeks growth ceased and the culture died. The following description of the fungus is derived entirely from the original material on its natural substratum.

Taxonomy

Elotespora R.F. Castañeda & Heredia, **anam. gen. nov.**

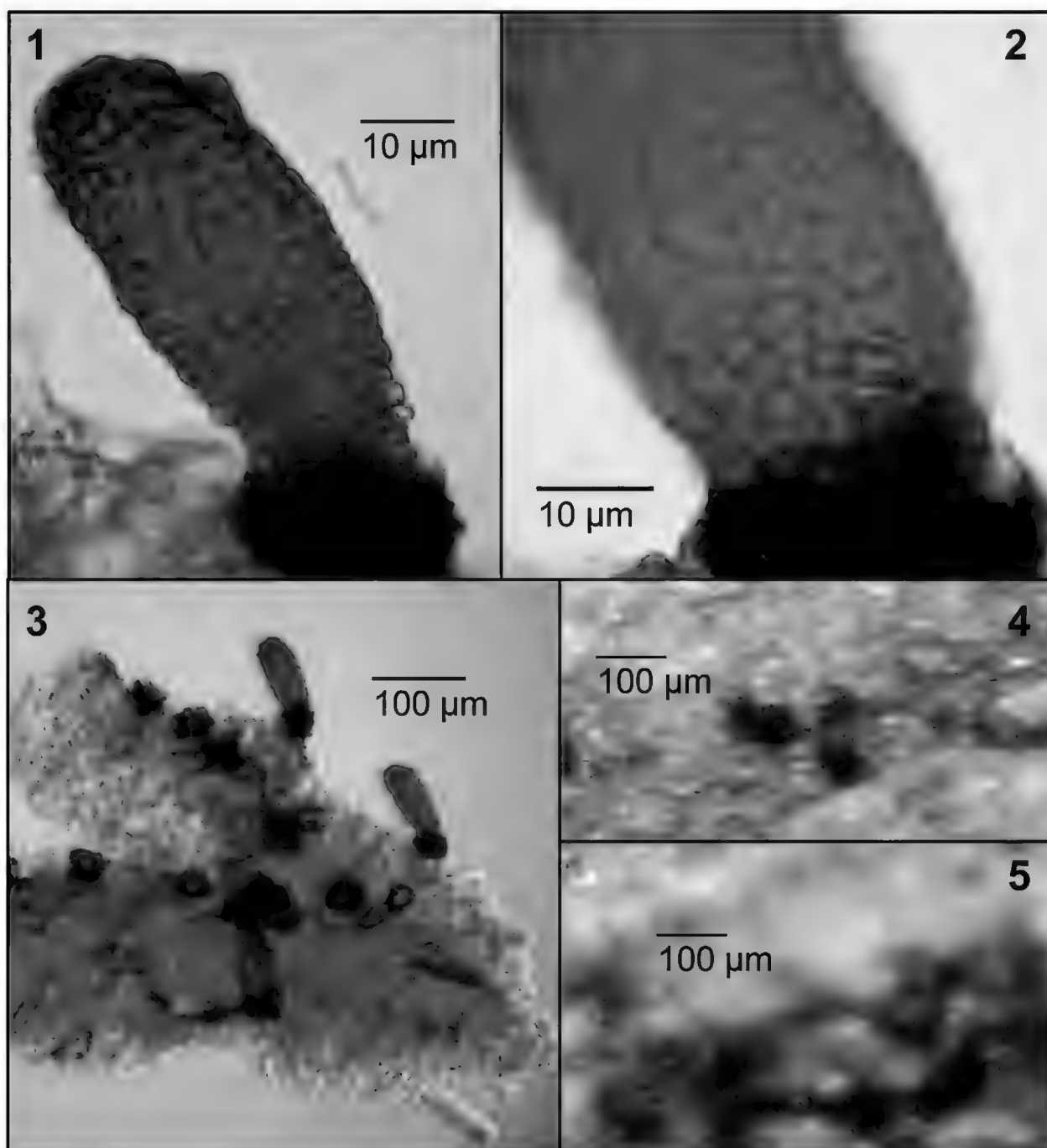
MYCOBANK MB 514126

Fungus anamorphicus. CONIDIOMATA in substrato naturali superficialia vel leviter immersa, stromatica, unilocularia, dissita, nidulantia, concava usque ad cupulata vel irregularia, brunnea vel atrobrunnea usque ad nigra, cum pariete ex cellulis texturae modo angularis composita; singulari quaeque singulo conidio praedita. CONIDIOPHORA non visa. CELLULAE CONIDIOGENAE non visae. CONIDIOGENESIS obscura, probabiliter holoblastica et monoblastica, probabiliter discreta, cum secessione fortasse schizolytica vel fortuitus rhexolytica. CONIDIA solitaria, muriformia, brunnea vel atrobrunnea, sicca, fusiformia, ovalia vel ellipsoidea vel cylindrica usque ad obovata, levia vel verrucosa. Teleomorphosis ignota.

ETYMOLOGY: Nahuatl tongue, *elote*-, meaning ear of corn; Latin, *-spora*, referring to the conidia.

SPECIES TYPICA: *Elotespora mexicana* R.F. Castañeda & Heredia

Anamorphic fungi. CONIDIOMATA on the natural substrate superficial or somewhat immersed, stromatic, unilocular, scattered, cyathiform, concave, cupulate to irregular, brown, dark brown to black. CONIDIOPHORES absent. CONIDIOGENOUS CELLS not observed. CONIDIOGENESIS obscure, probably holoblastic, monoblastic, discrete and conidial secession probably, fortuitously rhexolytic. CONIDIA solitary, muriform, brown or dark brown, fusiform, oval, ellipsoid, cylindrical to obovate, smooth or verruculose, dry. Teleomorph unknown.



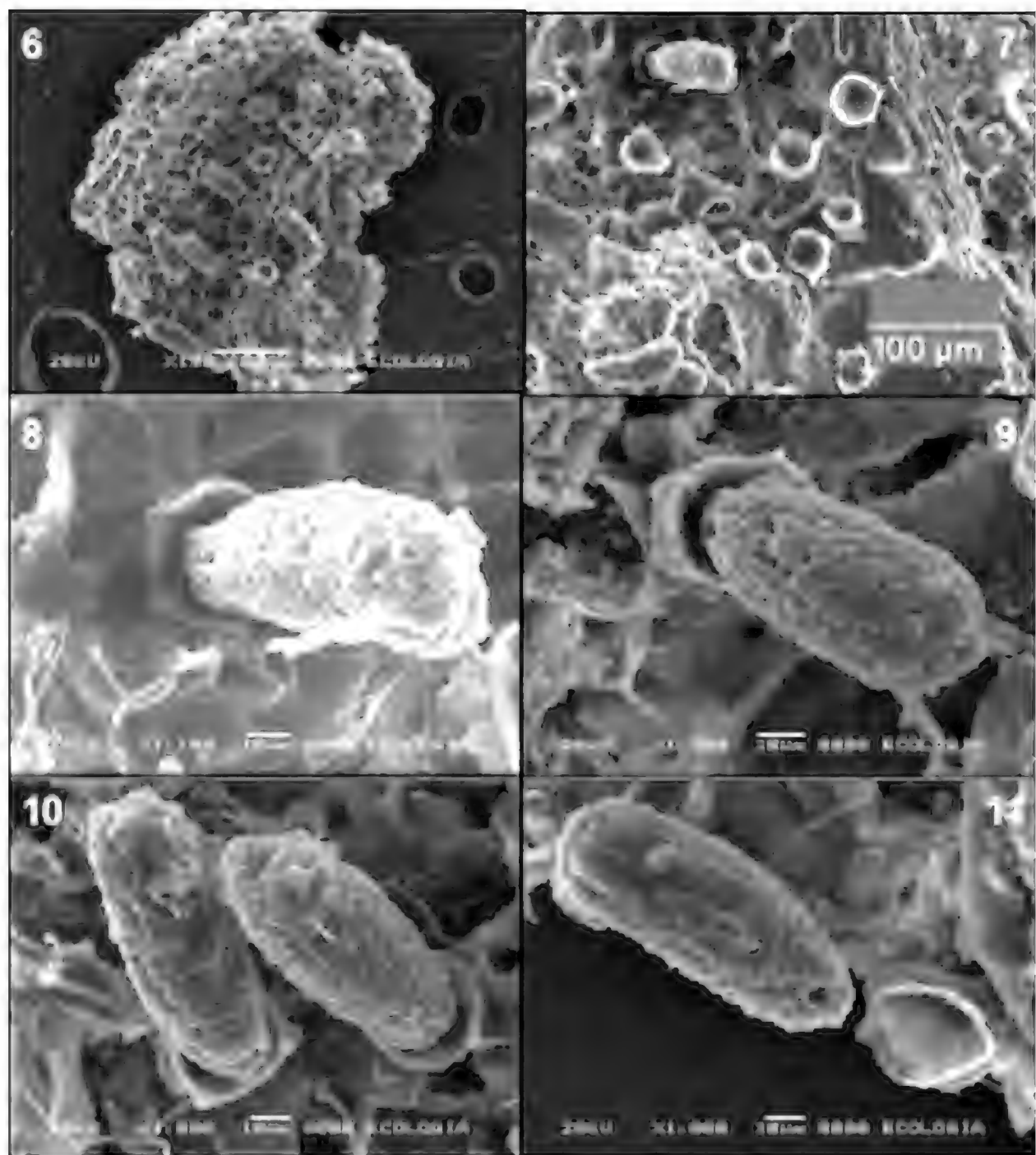
FIGS. 1–5. *Elotespora mexicana*, from holotype (XAL CB883). FIGS. 1–3. Conidiomata and conidia. FIGS. 4–5. Conidiomata on the substratum. Scale is indicated by bars.

Elotespora mexicana* R.F. Castañeda & Heredia, *anam. sp. nov.

MYCOBANK MB 514127

FIGS. 1–14

MYCELIUM plerumque in substrato immersum. *CONIDIOMATA* in substrato naturali superficialia vel leviter immersa, stromatica, unilocularia, dissita, nidulantia, concava ad usque cupulata vel irregularia, brunnea vel atrobrunnea usque ad nigra, 26–40 µm diam, 13–16 µm profunda, cum pariete ex cellulis uniseriate dispositis texturae modo angularis composita, sed bi- vel triseriate infra. *CONIDIOPHORA* non visa. *CELLULAE CONIDIOGENAE* non visae, sed ad centrum in parte interna conidiomatis fortasse dispositae. *CONIDIOGENESIS* obscura, probabiliter holoblastica et monoblastica, probabiliter discreta, cum secessione fortasse schizolytica vel. fortuitus rhexolytica. *CONIDIA* solitaria, muriformia, brunnea vel atrobrunnea, sicca, fusiformia, ovalia vel ellipsoidea vel cylindrica usque ad obovata, levia



FIGS. 6–11. *Elotespora mexicana*, photographs (SEM) from holotype (XAL CB883) Scale is indicated by bars.

vel verrucosa, interdum leviter curvata, 95–105 × 36–42 µm, truncata ad basim, obtusa ad apicem. Teleomorphosis ignota.

TYPE: MEXICO. TABASCO, LA VENTA, on decaying wood of an unidentified plant, 18.II.2004. G. Heredia (HOLOTYPE: XAL CB883).

ETYMOLOGY: Latin, *mexicana*, in reference to Mexico.

MYCELIUM mostly immersed. CONIDIOMATA unilocular, scattered, superficial or somewhat immersed, cyathiform, concave to cupulate, eustromatic, dark brown to black, 26–40 µm diam., 13–16 µm deep, composed of a series or layer of cells

forming a textura angularis, with 2–3 layers in the lower part. CONIDIOPHORES not observed. CONIDIOGENOUS CELLS not observed. CONIDIOGENESIS earlier stages not observed, but each conidium clearly produced from the lowest region inside the conidiomatal “cup” and, on the basis of observations with the scanning electron microscope, not attached at any point to the “cup” side walls. CONIDIAL SECESSION not observed but seceded conidia sometimes with part of the lowest portion of the conidial “cup” still attached. CONIDIA with a remarkable visual similarity to the cob of a maize plant, solitary, brown, dry, muriform, $95\text{--}105 \times 36\text{--}42 \mu\text{m}$, elongate ellipsoid, cylindrical to obovate, sometimes slightly curved, truncate at the base, obtuse or rounded at the apex. TELEOMORPH not observed.

Discussion

This beautiful fungus is astonishing because apparently only one conidium is produced in each conidioma and the spore is larger than the conidioma itself. It was not possible to elucidate the events of conidiogenesis in this fungus, particularly the earliest stages of development, as all attached conidia in the specimen were already multicellular and brown, an indication that much of the process of conidiogenesis had already occurred. It is not even clear whether each conidium is the product of a single conidiogenous cell, or of several cells acting in concert rather like a meristem. It seems likely that, in either case, the initiation of each conidium is probably holoblastic. Enteroblastic development is usually associated with systems producing large numbers of conidia, a strategy clearly not adopted by the present fungus.

The fact that part of the conidioma is sometimes seen still attached to the base of seceded conidia suggests that conidial secession is not through the simple schizolytic separation of a single two-ply septum. Like enteroblastic proliferation, schizolytic secession is particularly advantageous where many spores are produced from the same fertile cell. In the present fungus, where only one spore is produced from the conidioma, it seems likely that there has been no selective advantage to develop or maintain a system of schizolytic secession. Unpredictable conidial secession by fracture at a random point on the conidiophore is known from other fungi with conidiogenous development resulting in a single complex spore, for example *Slimacomycetes* Minter.

Although there are many anamorphic fungi that produce muriform spores, almost all are hyphomycetous. Very few have acervular, pycnidial, or sporodochial conidiomata. Most of the superficially similar fungi produce their conidia through well established patterns of conidial development.

Camarosporellum Tassi, *Camarosporium* Schulzer, and *Scolecosporiella* Petr. all form well-defined ostiolate pycnidia. Although conidiogenous cells of *Camarosporellum* and *Scolecosporiella* apparently each produce a solitary

conidium, unlike *E. mexicana* there are many conidiogenous cells within each conidioma and the conidiogenous cells themselves can be easily observed. In the case of *Camarosporium* conidiogenous cells proliferate enteroblastically with or sometimes without elongation, and thereby each produce several muriform spores. In passing, *Scolecosporella* is a particularly interesting fungus; given that teleomorphs are known in the *Pleosporales*, the *Alternaria*-like muriform conidia inside a *Phoma*-like pycnidium suggest some rather plastic truncation of two synanamorphs into one.

Dichomera Cooke, *Camarosporula* Petr. and *Myxocyclus* Riess all produce stromatic conidiomata. Those of *Dichomera* are enclosed and ostiolate; those of *Camarosporula* and *Myxocyclus* are acervular. All three produce many conidiogenous cells within each conidioma, and in all three, the conidiogenous cells can be readily observed. Conidiogenous cells of *Camarosporula* and *Myxocyclus* typically each produce a single spore, while those of *Dichomera* may occasionally proliferate percurrently with some elongation to produce “annellides”.

Some hyphomycetous fungi have micronematous or semi-macronematous conidiophores which produce muriform conidia, and some of these are produced from sporodochia with or without a rudimentary stroma. These include *Berkleasium* Zobel, *Canalisporium* Nawawi & Kuthub., *Coleodictyospora* Charles, *Hermatomyces* Speg., *Monodictys* S. Hughes, *Oncopodiella* G. Arnaud ex Rifai, *Oncopodium* Sacc., and *Pithomyces* Berk. & Broome. None of them has the distinct cupulate structure of the present fungus.

In *Zelosatchmopsis sacciformis* (R.F. Castañeda) Nag Raj & R.F. Castañeda (Saikawa et al. 1991) the initiation of conidia was described as holoblastic by apical wall-building in the first conidium and by replacement wall-building in subsequent conidia; maturation occurred by moderate diffuse wall-building asynchronously with ontogeny; conidium delimitation occurred by a double septum; secession was schizolytic. All information was obtained from a pure culture of *Z. sacciformis* (Saikawa et al. 1991). *Colemaniella ossoorii* Agnihotr. (Ellis 1976), also superficially similar to the present fungus, has superficial mycelium and globose to irregular hyphopodia on the hyphae; individual conidiogenous cells are cyathiform, striate and disposed on short branches; events of conidiogenesis are not clear. According to Ellis (1976), *C. ossoorii* is “considered by the author of the genus to be monotretic although this is difficult to establish with certainty.”

Conclusion

Although many developmental aspects remain to be elucidated, it is evident that the current organism is remarkable and, apparently, unique among anamorphic fungi. No other conidial fungus known to us is at all similar to it in terms of the

general form of its conidiomata and its highly distinctive cob-shaped conidia. We conclude that this fungus represents a new species in a new genus. These are now formally described.

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Literature cited

- Castañeda Ruiz RF, Stadler M, Saikawa M, Iturriaga T, Decock C, Heredia G. 2005. Microfungi from submerged plant material: *Zelotriadelphia amoena* gen. et sp. nov. and *Vanakripa fasciata* sp. nov. Mycotaxon 91: 339–345.
- Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Mycological Institute, Surrey, Kew.
- Figueras MJ, Guarro J. 1988. A scanning electron microscopic study of ascoma development in *Chaetomium malaysiense*. Mycologia 80: 298–306.
- Saikawa M, Castañeda Ruiz RF, Kendrick WB, Nag Raj TR. 1991. Genera coelomycetum 28. *Zelosatchmopsis* anam.-gen. nov. Can. J. Bot. 69: 630–633.

New combinations in *Phellinus* s.l. and *Inonotus* s.l.

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Abstract — In order to update the nomenclature of some species of poroid *Hymenochaetaceae*, the following new combinations are proposed: *Fulvifomes melleoporus*, *F. membranaceus*, *F. merrillii*, *Fuscoporia chrysea*, and *Inonotus portoricensis*.

Key words — *Agaricomycetes*, *Hymenochaetales*, polypore, taxonomy

Phellinus Quél. has been widely used to accommodate poroid species of *Hymenochaetaceae* with dimitic hyphal system and usually perennial basidiomata. Species with similar macroscopic features but having annual basidiomata and monomitic hyphal system have been placed in *Inonotus* P. Karst. (Pegler 1964; Gilbertson 1976, 1979; Larsen & Cobb-Poule 1990; Ryvarden 1991, 2004, 2005). However, many authors who do not accept these genera in this sense have suggested splitting them into smaller and more natural genera as supported by morphological and molecular evidence (Fiasson & Niemelä 1984; Niemelä et al. 2001; Wagner & Fischer 2001, 2002; Fischer & Binder 2004; Ghobad-Nejhad & Dai 2007).

Many species from the American continent have not been included in previous taxonomic and phylogenetic studies of *Phellinus* s.l. and *Inonotus* s.l. We propose the following new combinations in order to update the nomenclature of some of these species (for descriptions, see Fidalgo 1968, Wright & Blumenfeld 1984, and Ryvarden 2004):

***Fulvifomes melleoporus* (Murrill) Baltazar & Gibertoni, comb. nov.**

MYCOBANK MB 515285

BASIONYM — *Fomitiporella melleopora* Murrill, N. Amer. Fl. 9(1): 13 (1907).

KNOWN DISTRIBUTION — Neotropical species, known from Brazil, southern USA, and Venezuela (Larsen & Cobb-Poule 1990, Baltazar & Gibertoni 2009).

***Fulvifomes membranaceus* (J.E. Wright & Blumenf.) Baltazar & Gibertoni, comb. nov.**

MYCOBANK MB 515286

BASIONYM — *Phellinus membranaceus* J.E. Wright & Blumenf., Mycotaxon 21: 422 (1984).

KNOWN DISTRIBUTION — Neotropical species, known from northeastern Argentina, northeastern Brazil, Costa Rica, and Panama (Wright & Blumenfeld 1984, Ryvar den 2004, Baltazar & Gibertoni 2009).

***Fulvifomes merrillii* (Murrill) Baltazar & Gibertoni, comb. nov.**

MYCOBANK MB 515287

BASIONYM — *Pyropolyporus merrillii* Murrill, Bull. Torrey Bot. Club 34: 479 (1907).

KNOWN DISTRIBUTION — Probably pantropical but rare, known from northwestern Argentina, Brazil, China, Costa Rica, Nepal, southeastern USA, and Philippines (Larsen & Cobb-Poule 1990, Dai 1999, Ryvar den 2004, Robledo & Rajchenberg 2007, Baltazar & Gibertoni 2009).

COMMENTS — *Fulvifomes* Murrill is characterized by perennial basidiomata, lack of setae, and yellowish, thick-walled, ellipsoid basidiospores (Wagner & Fischer 2002). Pileate species usually have a rimose pileus, such as found in the *F. rimosus* complex. Resupinate species such as *F. melleoporus* and *F. membranaceus* are reminiscent of *Fomitiporella* Murrill, which has, however, brown basidiospores. The resupinate species of these two genera are separated mainly by basidiospore color, which is constant within each species.

***Fuscoporia chrysea* (Lév.) Baltazar & Gibertoni, comb. nov.**

MYCOBANK MB 515288

BASIONYM — *Polyporus chryseus* Lév., Ann. Sci. Nat., Bot., sér. 3 5: 301 (1846).

KNOWN DISTRIBUTION — Neotropical, known from Belize, Colombia, Costa Rica, Jamaica, and Venezuela (Ryvar den 2004).

COMMENTS — Species of *Fuscoporia* Murrill have hymenial setae, incrust ed generative hyphae in the dissepiments, and usually hyaline, thin-walled basidiospores. Basidiomata are annual to perennial with monomit ic to dimitic hyphal system (Niemelä et al. 2001, Wagner & Fischer 2002).

***Inonotus portoricensis* (Overh.) Baltazar & Gibertoni, comb. nov.**

MYCOBANK MB 515289

BASIONYM — *Fomes portoricensis* Overh., in Seaver & Chardón, Sci. Surv. Porto Rico & Virgin Islands 8(1): 158 (1926).

KNOWN DISTRIBUTION — Neotropical, known from Brazil, Costa Rica, Cuba, Mexico, Panama, and Puerto Rico (Fidalgo 1968). Lowe (1957) reports a specimen from Java that Fidalgo (1968) regards to be *Inonotus pachyphloeus* (Pat.) T. Wagner & M. Fisch.

COMMENTS — *Inonotus* s. str. accommodates species with hyphal system similar to that of *Fuscoporia*; however the former lacks incrust ed generative

hyphae and has pigmented basidiospores and usually setal hyphae (Wagner & Fischer 2002).

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Literature cited

- Baltazar JM, Gibertoni TB. 2009. A checklist of the aphyllorphoroid fungi (*Basidiomycota*) recorded from the Brazilian Atlantic Forest. *Mycotaxon* 109: 439–442.
- Dai YC. 1999. *Phellinus* sensu lato (*Aphyllorphorales*, *Hymenochaetaceae*) in East Asia. *Acta Bot. Fenn.* 166: 1–115.
- Fiasson JL, Niemelä T. 1984. The *Hymenochaetales*: a revision of the European poroid taxa. *Karstenia* 24: 14–28.
- Fidalgo O. 1968. *Phellinus pachyphloeus* and its allies. *Mem. New York Bot. Gard.* 17(2): 109–147.
- Fischer M, Binder M. 2004. Species recognition, geographic distribution and host-pathogen relationships: a case study in a group of lignicolous basidiomycetes, *Phellinus* s.l. *Mycologia* 96(4): 799–811.
- Ghobad-Nejhad M, Dai YC. 2007. The genus *Phellinus* s.l. (*Basidiomycota*) in Iran. *Mycotaxon* 101: 201–222.
- Gilbertson RL. 1976. The genus *Inonotus* (*Aphyllorphorales*: *Hymenochaetaceae*) in Arizona. *Mem. New York Bot. Gard.* 28(1): 67–85.
- Gilbertson RL. 1979. The genus *Phellinus* (*Aphyllorphorales*: *Hymenochaetaceae*) in western North America. *Mycotaxon* 9(1): 51–89.
- Larsen MJ, Cobb-Pouille LA. 1990. *Phellinus* (*Hymenochaetaceae*) A survey of the world taxa. *Syn. Fungorum* 3: 1–206.
- Lowe JL. 1957. *Polyporaceae* of North America. The genus *Fomes*. N. Y. State Univ. Coll. For. Tech. Publ. 80: 1–97.
- Niemelä T, Wagner T, Fischer M, Dai YC. 2001. *Phellopilus* gen. nov. and its affinities within *Phellinus* s. lato and *Inonotus* s. lato (*Basidiomycetes*). *Ann. Bot. Fennici* 38: 51–62.
- Pegler DN. 1964. A survey of the genus *Inonotus* (*Polyporaceae*). *Trans. Brit. Mycol. Soc.* 47(2): 175–195.
- Robledo GL, Rajchenberg M. 2007. South American polypores: first annotated checklist from Argentinean Yungas. *Mycotaxon* 100: 5–9.
- Ryvarden L. 1991. Genera of polypores, nomenclature and taxonomy. *Syn. Fungorum* 5: 1–363.
- Ryvarden L. 2004. Neotropical Polypores Part 1. Introduction, *Ganodermataceae* & *Hymenochaetaceae*. *Syn Fungorum* 19: 1–229.
- Ryvarden, L. 2005. The genus *Inonotus* a synopsis. *Syn. Fungorum* 21: 1–149.
- Wagner T, Fischer M. 2001. Natural groups and a revised system for the European poroid *Hymenochaetales* (*Basidiomycota*) supported by nLSU rDNA sequence data. *Mycol. Res.* 105: 773–782.
- Wagner T, Fischer M. 2002. Proceedings towards a natural classification of the worldwide taxa *Phellinus* s. l. and *Inonotus* s. l., and phylogenetic relationships of allied genera. *Mycologia* 94(6): 998–1016.

Wright JE, Blumenfeld SN. 1984. New South American species of *Phellinus* (*Hymenochaetaceae*).
Mycotaxon 21: 413–425.

Characterisation and neotypification of *Gloeosporium kaki* Hori as *Colletotrichum horii* nom. nov.

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Abstract — A neotype is designated for the persimmon anthracnose pathogen *Gloeosporium kaki* Hori and the fungus is transferred to *Colletotrichum* as *Colletotrichum horii* nom. nov. Molecular and morphological analyses place this species as a distinct group within the *Colletotrichum gloeosporioides* sensu lato species complex. The fungus is associated with dieback and canker of twigs and young branches of persimmon, as well as spots on unripe fruit. The disease occurs on persimmon in China, Japan, and Korea, and is reported for the first time from New Zealand.

Keywords — *Glomerella*, phylogenetic, taxonomy, *Diospyros kaki*

Introduction

The common persimmon (*Diospyros kaki* L.f.) has been cultivated in China, Japan, and Korea since prehistoric times, although it is probably of Chinese origin (Yonemori et al. 2008).

An anthracnose disease of persimmon is one of the most serious diseases of persimmon in Japan (Kitagawa & Glucina 1984), China (Kaiqi et al. 1988), and Korea (Lee et al. 2004). The fungus causing this disease was described in a Japanese language article by Shotaro Hori (1910a,b). He received specimens of the disease in July 1909 from an orchard planted in 1902 in the Mie prefecture and named the organism he isolated from the diseased fruits as *Gloeosporium kaki* on the basis of morphological traits similar to *Glomerella rufomaculans* (Berk.) Spauld. & H. Schrenk and *Gloeosporium fructigenum* Berk. (Hori 1910b).

The next year Seiya Ito (1911), probably unaware of the earlier work, published an article (in English) on the same persimmon fruit anthracnose pathogen, which he also named *Gloeosporium kaki*, although based on different specimens. In some works the authority for *G. kaki* has been given as Ito (e.g. Trotter 1931, von Arx 1957), probably due to the obscure place of publication

of Hori's name, "Engei no Tomo" (Friends of Horticulture). However, *G. kaki* Hori was validly published according to the rules of the botanical code of nomenclature at that time. The name is still in common use (e.g. Hu et al. 2006).

Maffei (1921) described a leaf spot pathogen of persimmon from a specimen collected in Italy. He speculated that his new species, *Colletotrichum kaki*, could be the same fungus as that described by Ito (1911) as *Gloeosporium kaki*. Von Arx (1970) agreed, stating that these two names referred to the same fungus. The seminal work of von Arx (1957) synonymised 750 *Gloeosporium* and *Colletotrichum* species to just 11 *Colletotrichum* species, and as part of this work *G. kaki* was placed in synonymy with *Colletotrichum gloeosporioides*, the conidial state of *Glomerella cingulata*.

In this paper we consider that Hori (1910b) and Ito (1911) described a fungus different from that of Maffei (1921). We neotypify *Gloeosporium kaki* Hori in order to stabilise and modernise the taxonomy of this pathogen, and transfer the taxon to *Colletotrichum*. We consider the persimmon pathogen a distinct taxon within the *Colletotrichum gloeosporioides* group species and report it from New Zealand for the first time.

Materials and methods

Isolates

New Zealand isolates were recovered from anthracnose lesions on persimmon fruit and twigs. Isolates from Japan were obtained from international culture collections; isolates from China were obtained from JZ Zhang (Zhang et. al. 2005). Living cultures have been deposited in the ICMP culture collection (Landcare Research, Auckland), and dried herbarium specimens in PDD and TNS.

Culture and morphology

Single conidial isolates were prepared and grown on Difco PDA at 18°C under a mixture of white and near UV light with a 12 h photoperiod. Colony morphology was noted after 12 days. Colour names follow Kornerup & Wanscher (1963). Conidia taken from actively growing, 7–10 day old cultures were examined for size and shape in lactic acid. Setae and appressoria were examined in lactic acid. Appressoria were producing using a slide culture. A small square of agar was inoculated on one side with conidia and immediately covered with a sterile cover slip. After 14 days the cover slip was removed and placed in a drop of lactic acid on a glass slide.

Phylogenetic analysis

DNA was extracted from pure cultures using a Corbett X-tractor Gene robot. PCR amplifications were done in an Applied Biosystems Veriti Thermal Cycler in 25 µL reactions with Roche FastStart Taq DNA Polymerase. The primers used were: Internal transcribed spacer — ITS: ITS1F (CTT GGT CAT TTA GAG GAA GTA A) (Gardes & Bruns 1993), ITS4 (TCC TCC GCT TAT TGA TAT GC) (White et al. 1990); Glycerol-3-phosphate-dehydrogenase – GPDH: GDF1 (GCC GTC AAC GAC CCC TTC ATT

GA), GDR1 (GGG TGG AGT CGT ACT TGA GCA TGT) (Templeton et al. 1992); and translation elongation factor – EF1 α : Ef728 (CAT YGA GAA GTT CGA GAA GG) (Carbone & Kohn 1999), EF2 (GGA RGT ACC AGT SAT CAT GTT) (O'Donnell et al. 1998). The PCR conditions for GPDH were: 4 min at 95°C, then 35 cycles of 95°C for 30 s, 60°C for 30 s, 72°C for 45 s, and then 7 min at 72°C. ITS and EF1 α conditions were identical with the exception of annealing temperatures of 52°C and 50°C, respectively.

DNA sequences were obtained in both directions on an Applied Biosystems 3130xl Avant Genetic analyzer using BigDye 3.1 chemistry, electropherograms were analysed and assembled in Sequencher 4.8 (Gene Codes Corp.). Multiple sequence alignments were made with PRANKSTER (Loytynoja & Goldman 2005). MrModelTest 2.3 (Nylander 2004) was used to determine the optimal analysis method. Bayesian inference trees were constructed with MrBayes 3.1.2 (Huelsenbeck & Ronquist 2001, Ronquist & Huelsenbeck 2003) for 10 million generations with no prior assumptions. The first 25% of generations before convergence were discarded. A phylogenetic tree was constructed for each gene individually.

Typification and taxonomy

Colletotrichum horii B. Weir & P.R. Johnst., nom. nov.

FIG. 1

MYCOBANK MB 514062

= *Gloeosporium kaki* Hori, Engei no Tomo 6(2): 21, 1910 [in Japanese], non *Colletotrichum kaki* Maffei 1921

= *Gloeosporium kaki* S. Ito, The Botanical Magazine, Tokyo 25: 201, 1911, nom. illegit. [later homonym]

TYPE: Japan, on *Diospyros kaki*, N. Nishihara A71, 1959, (TNS-F-26102 – dried culture here designated as **neotype** of *Gloeosporium kaki* Hori; isoneotype PDD 98210; living cultures derived from neotype – IFO 7478 = NBRC 7478 = ICMP 10492).

ETYMOLOGY: *horii*, after Prof. Shotaro Hori, Japanese researcher who first isolated and named *Gloeosporium kaki*.

Colonies on Difco PDA variable. Isolates from Japan 55–60 mm diam. after 12 days, colonies uniform in appearance, aerial mycelium low, pale grey (1B1), cottony, conidia develop across whole colony, forming slimy, pale orange (5A2) conidial masses mostly close to agar surface but also amongst the aerial mycelium, sometimes associated with dark-based conidiomata. In reverse, brown (6E6) pigments towards centre of colony, greenish grey (30E2) near margin, overlaid with narrow, darker concentric bands. Margin of colony regular. Conidiomata comprise groups of closely packed hyphae with short-cylindric to more or less globose cells 3.5–5 μ m diam. with walls dark and slightly thick. Setae scattered, 50–80(–140) μ m long, 6–8 μ m diam. at swollen basal cell, then tapering gradually to small, rounded apex, wall thick and dark. Conidiogenous cells held on the dark-walled cells, cylindric, 8–15 \times 3.5–5 μ m, wall thickened at the single apical conidiogenous locus. Conidia (13–)15–21(–23) \times 4–5.5 μ m (mean 17.6 \times 4.8 μ m, n = 76), straight, ends broadly rounded, mostly cylindric, a few tapering towards the base. Isolates from New Zealand and China 68–73

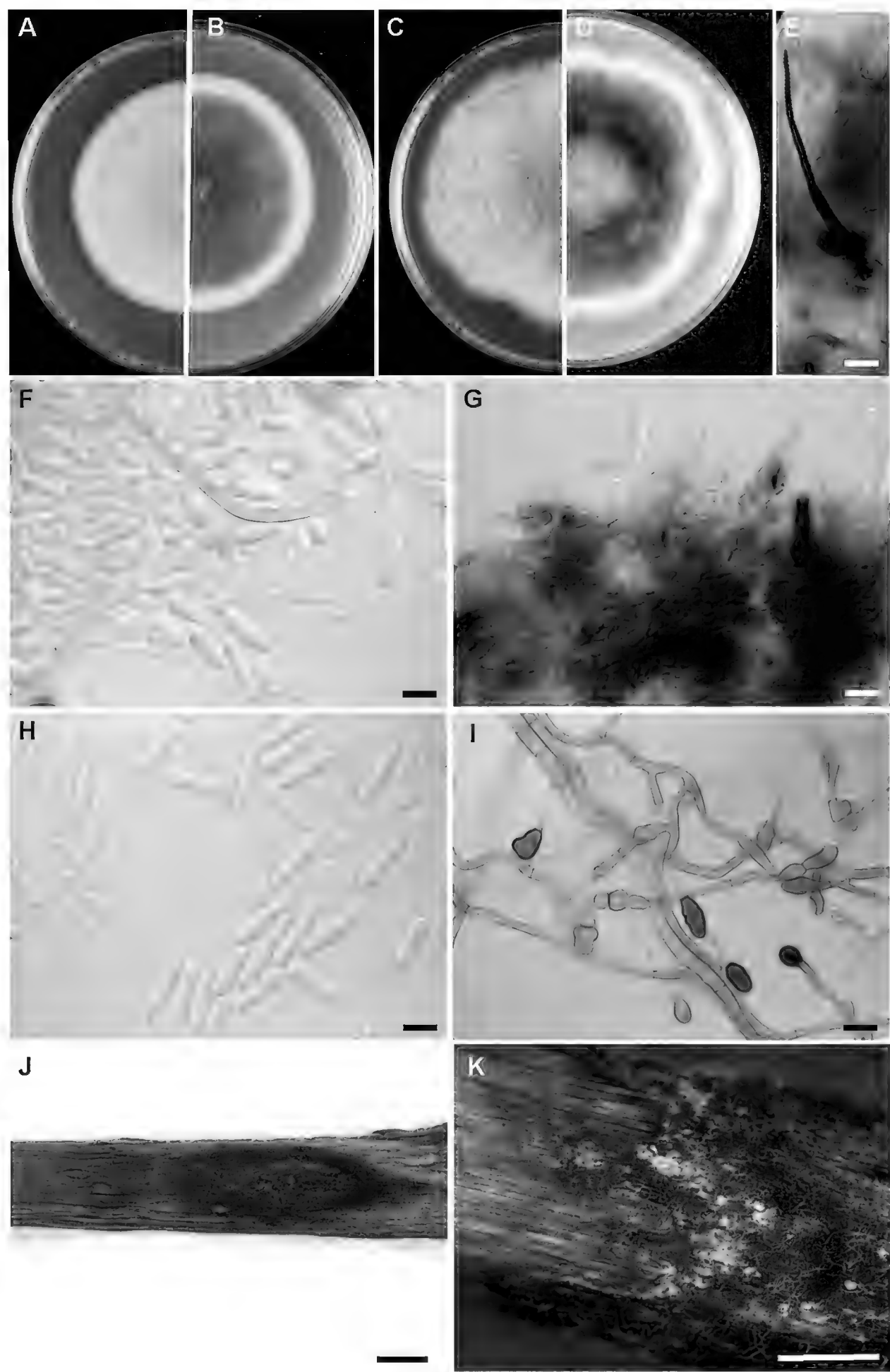
mm diam. after 12 days, colonies with aerial mycelium sparse, or dense and cottony, pale grey (1B1) to grey (1E1), sometimes with small clumps of dark grey (1F1) mycelium on surface, conidial ooze orange (6B7), restricted to tops of the dark, more or less round conidiomata. In reverse, dark conidiomata and orange spore masses show through from colony surface, sometimes overlaid with greenish grey (26F2) pigment within the agar. Margin of colony either regular or irregularly scalloped. Conidiogenous cells and setae the same as Japanese isolates. Conidia $16\text{--}29.5(-35) \times (4\text{--})4.5\text{--}6(-7) \mu\text{m}$ (mean $21.8 \times 5.0 \mu\text{m}$, $n = 182$), straight, ends broadly rounded, some cylindric but most taper gradually toward the basal end. Appressoria short-cylindric, usually uniform in outline, a few irregularly lobed, $9.5\text{--}13.5 \times 6\text{--}8.5 \mu\text{m}$.

HABITAT — Associated with lesions on unripe fruit, young stems, and twigs. On unripe fruit, lesions slightly sunken, more or less round, very dark to black, acervuli erumpent covered with orange conidial masses, present near centre of lesions. Twigs and young stems with tip dieback and lesions, dark grey to black, elliptic, extending along one side of stem, erumpent acervuli and pale conidial masses near margins of lesions, bark often lost from stem in central part of lesion.

OTHER COLLECTIONS EXAMINED — China: on *Diospyros kaki* rot of unripe fruit, Jingze Zhang, May 2002 (TSG001 = ICMP 17968 and TSG002 = ICMP 17969 – living cultures). Japan: Fukuoka, on *D. kaki* young shoot, Y. Kajitani, May 1993 (MAFF 306429 = ICMP 17970 – living cultures). New Zealand: Northland, Ohaewai, Hall-Wright orchard, on *D. kaki* rot of unripe fruit, A. Clarke, 1990 (PDD 62825 – dried herbarium specimen, ICMP 12951 – living culture derived from herbarium specimen). Bay of Plenty, Te Puke, on *D. kaki* lesions on living stems and unripe fruit, S. Parkes, P. Glucina, Jan. 1989 (PDD 57148 – dried herbarium specimen, ICMP 12942 – living culture derived from herbarium specimen). Bay of Plenty, Te Puke, on *D. kaki* rot of unripe fruit, M.A. Manning MM150, June 2002 (ICMP 14918 – living culture). Bay of Plenty, Katikati, on *D. kaki* ripe fruit rot, M.A. Manning, 15 June 1989 (PDD 55534 – dried herbarium specimen, ICMP 18126 – living culture derived from herbarium specimen).

NOTES — The specimen cited by Hori (1910b; Honshu, Mie Prefecture, on *Diospyros kaki* fruit, S. Hori, 31 July 1909) is not present in the TNS herbarium (Tsuyoshi Hosoya, pers. comm.) and is assumed to have been destroyed or not originally preserved; it is unlikely to be present in other herbaria in Japan.

FIG. 1. *Colletotrichum horii*. A, top; and B, reverse, of 12 day old culture on PDA, initiated from a single conidium (ICMP 10492, PDA subculture, ex neotype, Japan). C, top; and D, reverse, of 12 day old culture on PDA, initiated from a single conidium (ICMP 12942, PDA subculture, New Zealand). E, seta. F, H, conidia in lactic acid. G, acervulus, squash mount. I, appressoria in culture. J, young lesion on living twig. K, margin of older lesion on twig, sporulating acervuli erumpent through bark at margin of lesion, bark lost from central part of lesion. A–B, E–G, ICMP 10492; C–D, H, ICMP 12942; I, ICMP 17970; J–K, PDD 57148. Scale bars E–I = 10 μm , J–K = 2 mm.



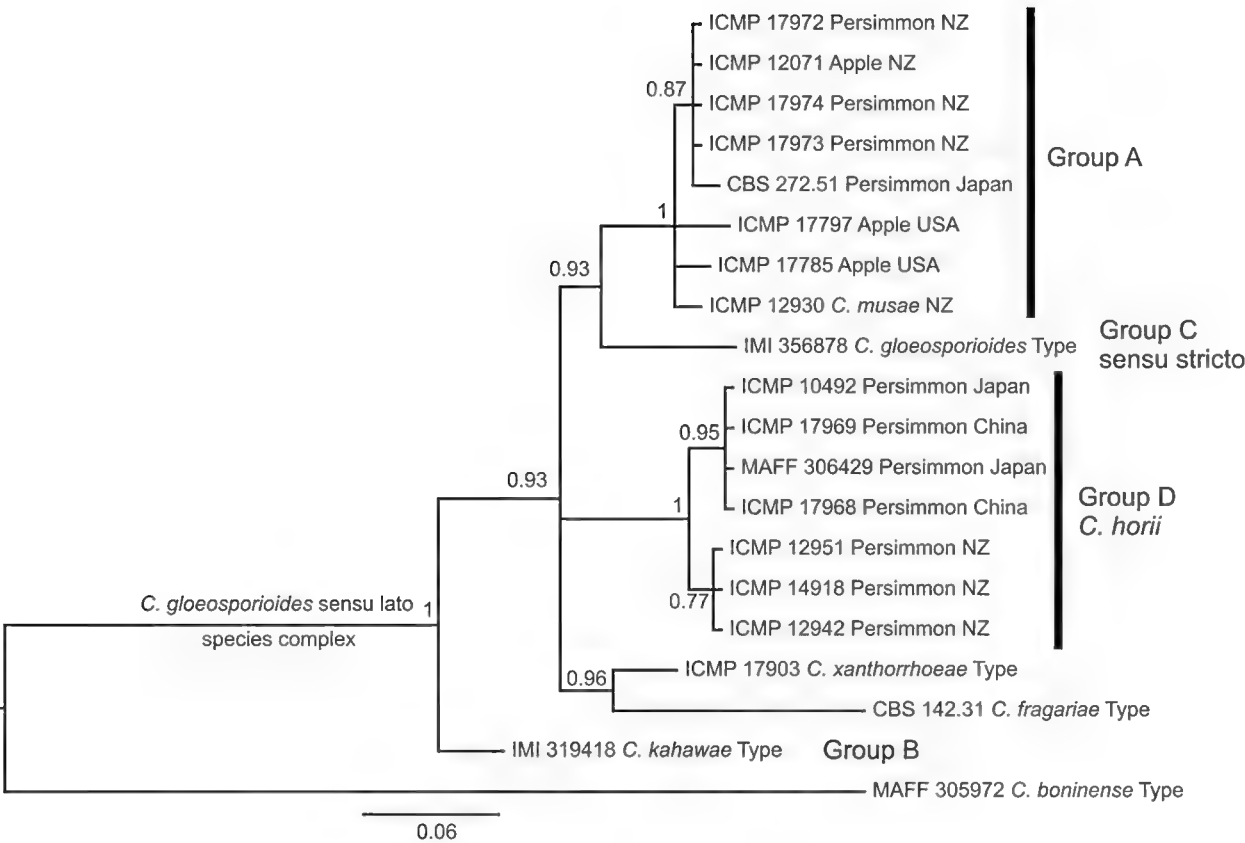


FIG. 2. 50% majority-rule consensus Bayesian inference phylogenetic tree of intron 2 of the GPDH gene. The tree shows the relationship of *Colletotrichum horii* isolates to other described species and relevant isolates within the *C. gloeosporioides sensu lato* species complex, and is rooted with *C. boninense*. Clades labelled as Groups A–D are sensu Johnston & Jones (1997). Clade posterior probabilities are indicated at nodes. Scale bar shows number of inferred changes per site.

The neotype we selected matches the original description of this fungus (Hori 1910a,b, Ito 1911) both morphologically and biologically. Although not from the site where the holotype was collected, it is from the same country. Because species level taxonomy of *Colletotrichum* is increasingly becoming based on molecular phylogenetic analyses, we have selected a type specimen that is available as a living culture, allowing practical and repeated DNA isolation for future genetic studies.

Appearance of the isolates of *C. horii* in culture is variable and this variation appears to reflect geographic origin of the isolates. Compared with the fresh isolates from New Zealand and the Chinese isolates, the Japanese isolates have a slower growth rate, conidia are not always associated with dark-based acervuli, the acervuli that are present are smaller in size, and the conidia are smaller. The New Zealand isolates from Northland differ from those from the Bay of Plenty in lacking dark grey pigment within the agar and in having a uniform rather than irregularly scalloped colony margin. The Chinese isolates are similar to those from New Zealand in having conidial production more or less confined to scattered, dark-based acervuli. Because of the genetic and biological similarity between the isolates from all of these localities, the variation

in cultural appearance is considered as within-species variation. In addition, the storage history of the Japanese isolates is not known, and the differences may relate to changes in cultural appearance following repeated subculturing, a common occurrence in *Colletotrichum*.

Phylogenetic analyses

All gene trees were congruent, and generally resolved the same major clades as shown in the GPDH tree (FIG. 2). Clades are labelled Group A–D in the sense of Johnston & Jones (1997), with Group A = Clade 1 and Group B = Clade 2 of Johnston et al. (2008). The GPDH tree had the most variation and best resolution of the genes sequenced for the species within the *C. gloeosporioides* complex. The posterior probabilities of the clades in the GPDH tree were very high between groups ranging from 0.93–1.00 indicating strong support for this topology. The posterior probabilities were generally lower (0.77, 0.87, and 0.95) within groups. The ITS gene tree had poor resolution of clades within the *C. gloeosporioides* sensu lato complex. Sequences of *C. horii* genes have been deposited in GenBank as ITS (GQ329687 – GQ329690), GPDH (GQ329680 – GQ329686), EF1 α (GQ329691 – GQ329697). Sequences of other all isolates, including types have been deposited as (GU174542 – GU174577). Trees and alignments are available at TreeBASE # S2470.

Discussion

Phylogenetics

Prior to the 1950s the taxonomy of *Colletotrichum* was complicated with many species names based solely on host and without reference to other material. Von Arx (1957) synonymised 750 names to just 11 *Colletotrichum* species, based on morphological similarities. However, this led to the creation of large “group-species” such as *Colletotrichum gloeosporioides* that are genetically and biologically highly diverse. Johnston & Jones (1997) found five morphologically and genetically distinct groups within *C. gloeosporioides* sensu lato isolates from New Zealand (Groups A–D, and *C. musae*); this work was later supported with a multigene phylogeny with a geographically expanded range of isolates (Johnston et al. 2008). The recent typification of *C. gloeosporioides* sensu stricto (Cannon et al. 2008) has clarified the taxonomy of this species, and its relationship to other members of the *C. gloeosporioides* species complex, including *C. musae*, *C. kahawae*, *C. fragariae*, and *C. xanthorrhoeae* (FIG. 2).

Johnston et al. (2008) recognised a distinct persimmon-specialised clade within the *C. gloeosporioides* complex on the basis of a multigene phylogeny. Here we formally name that clade *Colletotrichum horii*. The tree we present (FIG. 2) is based on the intron 2 sequence of the GPDH, as tree topologies from this gene closely replicated those of the multigene topology. Sequences of the

translation elongation factor (EF1 α) and the internal transcribed spacer (ITS) were identical across all *C. horii* isolates sequenced. The sequences of GPDH intron 2 varied by 7 bp between Asian and New Zealand isolates, as a result of a 3 bp indel and four single nucleotide transitions. It is unlikely that this variation has evolved in New Zealand. Although persimmon has been grown in New Zealand for more than 100 years, the disease associated with *C. horii* has been noticed only recently and it may even have been accidentally introduced in very recent times (see discussion below). More extensive studies of *C. horii* throughout Asia are likely to reveal greater levels of genetic diversity within the species.

The neotypification of *Colletotrichum horii* in this publication will stabilise and modernise the taxonomy of this species. This will in turn allow the application of molecular diagnostic tools, allowing more accurate and specific detection of persimmon pathogens than have previously been possible. For example, the method of Lee et al. (2004) fails to distinguish several different *Colletotrichum* species, any of which could potentially occur on persimmon, but with only *C. horii* likely to be of practical concern on this host.

Synonyms of *Colletotrichum horii*

The name *Gloeosporium kaki* has been proposed twice, one year and 400 km apart on Honshu, Japan (Hori 1910a,b, Ito 1911). Due to the similarity in biology, disease symptoms, and morphology we assume that both authors described the same organism.

Colletotrichum kaki was described in 1921 by Maffei as a leaf disease affecting specimens of *Diospyros kaki* cv. Kiombo in the Pavia botanic gardens in Italy. The disease, possibly associated with previous physical damage, started with hazel spots on the leaf margin or apex of mature leaves, and expanded in concentric rings until the leaves dried and fell. Although Maffei (1921) speculated that his organism could be the same as that of Ito (1911), the different biology of the disease would suggest otherwise. Isolates of *C. horii* are consistently associated with lesions on young twigs and shoots and as spots of unripe fruit. Morphologically they differ in that Maffei (1921) described a fungus with numerous setae, whereas *C. horii* produces few or no setae on host tissue, and sparsely in culture. There is no evidence that *Gloeosporium kaki* and *Colletotrichum kaki* are synonyms.

Other reports of *Colletotrichum gloeosporioides* infecting persimmon fruit are impossible to assess accurately with respect to the species being discussed, without extant cultures and genetic data (e.g. Maffei 1921, Moreau 1945). However, the descriptions of associated symptoms reported by da Silva (1940), where he described black, sunken lesions on unripe fruit, suggest that *C. horii* may also occur in Brazil.

Host specificity of *Colletotrichum horii*

From the earliest literature, there have been suggestions that *C. horii* may occur on other hosts. For example, Hori (1910b) noted that his isolates were pathogenic to pear. Ito (1911) inoculated a ripe apple and observed disease symptoms identical to those on persimmon, although *Colletotrichum* isolates from bitter rot symptoms of apple were not pathogenic to persimmon. Ikata (1936) inoculated isolates identified as *Gloeosporium kaki* on to ripe *Capsicum annuum* fruit. Such an apparent lack of specificity is not surprising. Johnston (2000) discussed a similar situation with *Glomerella miyabeana*, a pathogen of *Salix* found incidentally on a range of other plants.

Colletotrichum horii in New Zealand

Persimmon plants were first imported into New Zealand in 1873 with the intention of growing persimmons as a crop (Kitagawa & Glucina 1984). However, following their initial introduction they were grown largely as garden plants, until the early 1980s when commercial interest was revived with the importation from Japan of a wide range of cultivars for testing under New Zealand conditions (Kitagawa & Glucina 1984). It is likely that the diseased specimens from New Zealand cited in this paper originated from plants propagated from the material imported in the 1980s. It is possible that the disease was introduced with these plants as an anthracnose disease of persimmon had not been recorded in New Zealand previously (Pennycook 1989). It is possible that only one or a few of the newly imported cultivars was susceptible but we have no information on which cultivars were infected. Kitagawa & Glucina (1984) noted that anthracnose is one of the most serious diseases of persimmon in Japan, but that large differences in resistance occur between cultivars.

In addition to *C. horii* two other *Colletotrichum* species have been isolated from persimmon fruit in New Zealand. *C. gloeosporioides* Group A (sensu Johnston & Jones 1997) has been found on ripe persimmon fruit. In New Zealand this fungus is commonly associated with bitter rot disease of apples and as a ripe rot on several other fruits (Johnston & Jones 1997). A collection from persimmon from Japan (CBS 272.51 = IMI 086556 = ICMP 17941) belongs in the same clade, but is genetically slightly different (2 bp in GPDH) to the New Zealand isolates. *C. acutatum* has also been isolated from ripe persimmon fruit. Neither of these other two fungi causes a problem with persimmon in New Zealand.

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References

- von Arx JA. 1957. Die Arten der Gattung *Colletotrichum* Cda. *Phytopathologische Zeitschrift* 29: 413–468.
- von Arx JA. 1970. A revision of the fungi classified as *Gloeosporium*. *Bibliotheca Mycologica* 24: 1–203.
- Cannon PF, Buddie AG, Bridge PD. 2008. The typification of *Colletotrichum gloeosporioides*. *Mycotaxon* 104: 189–204.
- Carbone I, Kohn LM. 1999. A method for designing primer sets for speciation studies in filamentous ascomycetes. *Mycologia* 91: 553–556.
- Da Silva G. 1940. A antracnose do caqui. *Biologico* 6: 125–126.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes — application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118.
- Hori S. 1910a. Kaki no Shinbyogai Tansobyō. *Engei no Tomo* 6(1): 58–61.
- Hori S. 1910b. Kaki no Shinbyogai Tansobyō. *Engei no Tomo* 6(2): 21–24.
- Hu SC, Li M, Wang JG, Liu CH. 2006. IFB-Lactam-1, a natural compound with anti-*Gloeosporium kaki* Hori activity. *Acta Crystallographica Section E: Structure Reports Online* 62: o5777–o5778.
- Huelsenbeck JP, Ronquist F. 2001. MRBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics* 17: 754–755.
- Ikata S. 1936. The function and formation of setae on some anthracnose fungi. *Agric & Hort* 5: 360–362.
- Ito S. 1911. Gloeosporiose of the Japanese persimmon. *The Botanical Magazine (Tokyo)* 25: 197–202.
- Johnston PR. 2000. The importance of phylogeny in understanding host relationships within *Colletotrichum*. 21–28, in Prusky D, Freeman S, Dickman MB (eds.), *Colletotrichum: Host Specificity, Pathology, and Host-Pathogen Interaction*. APS Press, St Paul.
- Johnston PR, Dodd S, Park D, Massey B, Charuchinda B, Waipara N, Buckley T. 2008. Are stable, consistent, reliable, and useful species names possible within *Colletotrichum*? 1–9, in *Colletotrichum Diseases of Fruit Crops*, Pre-Congress workshop, ICPP 2008, Torino, Italy.
- Johnston PR, Jones D. 1997. Relationships among *Colletotrichum* isolates from fruit-rots assessed using rDNA sequences. *Mycologia* 89: 420–430.
- Kaiqi L, Huifang M, Fengying L. 1988. Studies on persimmon anthracnose (*Gloeosporium kaki* Hori). *Journal of Shandong Agricultural University*. 19: 69–71.
- Kitagawa H, Glucina P. 1984. Persimmon culture in New Zealand. DSIR Information Series 159. Science Information Publishing Centre: Wellington, New Zealand. 74pp.
- Kornerup A, Wanscher JH. 1963. 'Methuen handbook of colour.' Methuen and Co: London.
- Lee JH, Han KS, Lee SC, Shim CK, Bae DW, Kim DL, Kim HK. 2004. Early detection of epiphytic anthracnose inoculum on phyllosphere of *Disopyros kaki* var. *domestica*. *Plant Pathology Journal* 20: 247–251.

- Loytynoja A, Goldman N. 2005. An algorithm for progressive multiple alignment of sequences with insertions. *Proceedings of the National Academy of Sciences of the United States of America* 102: 10557–10562.
- Maffei L. 1921. Una malattia delle foglie del “Kaki” dovuta al *Colletotrichum kaki* n. sp. *Rivista di Patologia Vegetale* 11: 116–118.
- Moreau C. 1945. Sur le *Gloeosporium kaki* Seiya Ito. *Rev Mycologie* 10: 125–127.
- Nylander JAA. 2004. MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.
- O’Donnell K, Kistler HC, Cigelnik E, Ploetz RC. 1998. Multiple evolutionary origins of the fungus causing Panama disease of banana: concordant evidence from nuclear and mitochondrial gene genealogies. *Proceedings of the National Academy of Sciences of the United States of America* 95: 2044–2049.
- Pennycook SR. 1989. Plant diseases recorded in New Zealand. Plant Diseases Division, DSIR, Auckland.
- Ronquist F, Huelsenbeck JP. 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
- Templeton MD, Rikkerink EHA, Solon SL, Crowhurst RN. 1992. Cloning and molecular characterization of the glyceraldehyde-3-phosphate dehydrogenase-encoding gene and cDNA from the plant pathogenic fungus *Glomerella cingulata*. *Gene* 122: 225–230.
- Trotter A. 1931. Supplementum universale Pars X. *Myxomycetae, Myxobacteriaceae, Deuteromycetae, Mycelia sterilia*. *Sylloge Fungorum* 25: 1–1093.
- White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. 315–322, in Innis MA, Gelfand DH, Sninsky JJ, White TJ (eds.), *PCR Protocols: A Guide to Methods and Applications*. Academic Press: New York.
- Yonemori K, Honsho C, Kanzaki S, Ino H, Ikegami A, Kitajima A, Sugiura A, Parfitt DE. 2008. Sequence analyses of the ITS regions and the matK gene for determining phylogenetic relationships of *Diospyros kaki* (persimmon) with other wild *Diospyros* (*Ebenaceae*) species. *Tree Genetics and Genomes* 4: 149–158.
- Zhang JZ, Xu T, He LP. 2005. Anthracnose pathogen on *Diospyros kaki* cv. Wuheshi and its nuclear behavior in process of appressorium formation. *Mycosystema* 24: 446–456 (in Chinese).

***Metacordyceps guniujiangensis* and its *Metarhizium* anamorph: a new pathogen on cicada nymphs**

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Abstract — A new species, *Metacordyceps guniujiangensis*, collected from Guniujiang Nature Preserve in Anhui Province, southeastern China, is described and illustrated. The anamorph isolated from the ascospores is determined as *Metarhizium* aff. *cylindrosporum*. Sequence comparisons of 5.8S ribosomal RNA and complete internal transcribed spacer (ITS) regions from *Metacordyceps guniujiangensis* and *M.* aff. *cylindrosporum* show that the two taxa share the same ITS1-5.8S-ITS2 nucleotide sequences, strongly supporting *M. guniujiangensis* as the teleomorph of *M.* aff. *cylindrosporum*. Molecular phylogenetic analysis agrees with the morphological results and demonstrates that the *M. guniujiangensis* conidial isolate belongs to the genus *Metarhizium*. The phylogenetic tree and ITS sequence show the anamorphic species closely related to *M. cylindrosporum* with a variance at 9.3% (35 bp). The type specimen is deposited at Research Center for Entomogenous Fungi (RCEF), Anhui Agricultural University, China.

Keywords — anamorph-teleomorph connection, *Clavicipitaceae*, entomopathogenic fungi

Introduction

The genus *Cordyceps* Fr. is a group of entomogenous fungi. The earliest description of a *Cordyceps* (*Clavicipitales: Clavicipitaceae*) can be traced to 800 A.D. (Wang 1995). About 400 species of *Cordyceps* and related genera have been reported around the world (Kobayasi & Shimizu 1983, Shimizu 1994), of which approximately 120 have been recorded in China (Liang 2007). Sung et al. (2007) recently segregated the polyphyletic genus into several genera. Among them is the genus *Metacordyceps* G.H. Sung et al., established for several species of *Cordyceps* sensu lato, based on the phylogenetic placement of *C. taii* (Sung et al. 2007).

It is important to identify the anamorphic states of *Cordyceps* sensu lato species correctly for both academic and practical reasons because some species

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have potential value as pharmaceuticals and biological pest controls. However, progress in isolating and verifying *Cordyceps* anamorphs has been very slow. So far, over around seventy *Cordyceps* anamorphs representing twenty genera have been reported. *Hirsutella* Pat., *Hymenostilbe* Petch, and *Paecilomyces* Bainier represent the three principal genera. Other genera such as *Metarhizium* Sorokin and *Nomuraea* Maubl. contain a few anamorphs of *Cordyceps*.

The difficulty of inducing sexual reproduction in artificial culture has limited our knowledge of anamorph-teleomorph connections in these fungi. Kobayasi (1941) presented five criteria for determining *Cordyceps* anamorphs. Liang (1991) proposed an approach based upon microcycle conidiation of secondary ascospores. Currently, ribosomal RNA sequence analysis has provided a powerful molecular tool to clarify the relationships between ascogenous and conidial states. The internal transcribed spacers (ITS), which are more variable than the large and small subunit sequences, have been used to analyze intrageneric or intraspecific relationships by many researchers (Huang et al. 2002; Liu et al. 2001, 2002; Chen et al. 2001; Obornik et al. 2001; Sung et al. 1999; Zhao et al. 1999).

In *Metarhizium*, species relationships and delimitation have been systematically studied using RAPD-PCR (Leal et al. 1994) and ITS analyses (Curran et al. 1994, Driver et al. 2000). Liu et al. (2001) demonstrated the connection of *M. guizhouense* Q.T. Chen & H.L. Guo to its teleomorph, *Cordyceps taii* Z.Q. Liang & A.Y. Liu, through ITS analysis. *M. anisopliae* var. *majus* (J.R. Johnst.) M.C. Tulloch was confirmed as the anamorph of *C. brittlebankisoides* Zuo Y. Liu et al. when the ITS sequence from field-collected stroma proved to be identical to that of the culture (Liu et al. 2001).

An entomogenous fungus collected from southern Anhui, China, during the present study is described here as a new species, *Metacordyceps guniujiangensis*. An isolate derived from its ascospores was determined to be its anamorph, *M. aff. cylindrosporum*. This conclusion was supported by comparison of 5.8S rRNA and ITS sequences.

Materials and methods

Specimen and fungal isolates

A specimen (GNJ020527-04) was collected from the National Nature Conservation of Gunuijiang, Shitai County, southern Anhui, China, N30°02'05'' E117°26'26'', altitude about 500 m. Its host was the soil-dwelling nymph of an unidentified cicada. A hyphomycete was isolated from ascospores discharged onto glass slides according to the method of Li et al. (1999) and was identified as *M. aff. cylindrosporum* (RCEF2001). The specimen was freeze-dried and stored at 4°C after isolation and teleomorphic description. Morphological characteristics of the cultures incubated on malt extract agar (MEA) and Czapek-Dox agar at 25°C for 14 days were recorded (Tzean et al. 1993).

Sequence data and analysis

DNA preparation, PCR amplification, purification of amplification products, DNA cloning and sequencing of the amplified ITS region followed the protocol of Huang et al. (2002) using primers ITS1 and ITS4.

Sequence data of *M. guniujiangensis* and *M. aff. cylindrosporum* were submitted to GenBank (Accession numbers AY913757 and AY913758, respectively) and were compared with available ITS sequences of *M. cylindrosporum* (ACCC30114, ex type strain), *M. viridulum* (AF368500), *Nomuraea rileyi* (AF368501), *M. anisopliae* var. *anisopliae* (AF135210) and *M. flavoviride* var. *flavoviride* (AF138270) retrieved from GenBank.

Alignments and analysis

Sequences were aligned with Clustal X (Thompson et al. 1994) and positions with gaps (coded as a 5th character) are included. A phylogenetic tree was constructed using neighbor-joining methods using TreeconW in the Treecon software package (Van de Peer & De Wachter 1994). *Beauveria bassiana* (AF347162) was used as an outgroup. 1000 replicates of bootstrap analysis were completed.

Results

Metacordyceps guniujiangensis C.R. Li, B. Huang, M.Z. Fan & Z.Z. Li, sp. nov.

MYCOBANK MB 511341

FIG. 1

Stromata 2, *stipite basi confluentia, ex capite hospitis, atrovirentia, curvata*, 40.3–42.5 mm *longa*, *stipite cylindrica*, 2.5–2.7 mm *crassa*. *Pars fertilis* 8.8–11.1 × 2.7–3.2 mm, *sterili apice attenuato, luteo, glabello*, 5.6–11.1 mm *longo*, 2.5–3.0 mm *crasso basi*. *Perithecia curvato-ampullacea, penitus oblique immersa*, 640–770 × 240–320 µm. *Asci cylindrici*, 310–380 × 4.0–4.8 µm, *cum pileo asci* 2.8–3.0 µm *diam*. *Ascosporae filiformes*, 240–330 × 0.8–1.0 µm, *laeves, multiseptatae, nonsecedentes, cellulis* 8–17 µm *longis*. *In larvis cicada*.

HOLOTYPE—National Natural Reserve of Gunuijiang, Shitai County, southern Anhui, P.R. China, 27 V 2002. On nymph of a cicada (*Homoptera: Cicadidae*). Coll. C. R. Li. GNJ020527-04; deposited at Research Center on Entomogenous Fungi, Anhui Agricultural University, China.

ANAMORPH—*Metarhizium* aff. *cylindrosporum*

Stromata two, *stipes* 2.5–2.7 mm thick, confluent at basal part, arising from the head of the larval cicada host, dark green, curving, 40.3–42.5 mm long; Fertile part 8.8–11.1 × 2.7–3.2 mm, not clearly defined from the stipes, apically subulate, with acute, yellow and glabrous sterile tip, 5.6–11.1 mm long, 2.5–3.0 mm wide at the base of sterile tip; *Perithecia* ampullaceous, obliquely immersed, with curved neck, 640–770 × 240–320 µm. *Asci* cylindrical, 8-spored, 310–380 × 4.0–4.8 µm, ascus cap 2.8–3.0 µm in diameter. *Ascospores* hyaline, filiform, 240–330 × 0.8–1.0 µm when discharged, smooth, multiseptate with cells 8–17 µm long, not breaking into secondary ascospores.

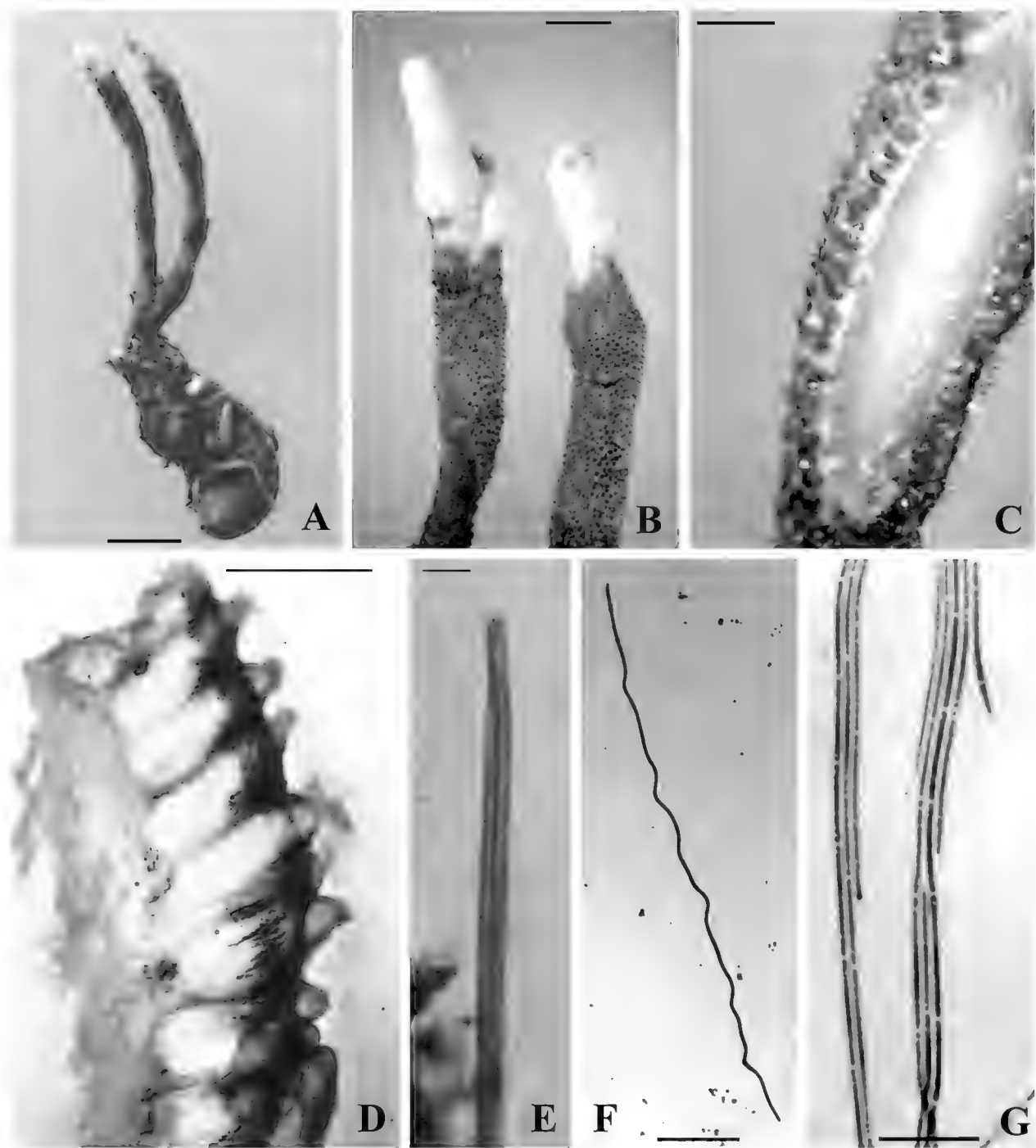


FIG. 1. *Metacordyceps guniujiangensis* A. Stromata of *Metacordyceps guniujiangensis*, bar = 1 cm; B. Fertile stromata showing fertile part and sterile tip, bar = 2.5 mm; C. Section showing oblique orientation of perithecia, bar = 1 mm; D. Perithecia, bar = 500 μ m; E. Upper part of an ascus, bar = 5 μ m; F. A discharged ascospore, bar = 50 μ m; G. Multiseptate nonfragmenting ascospores, bar = 10 μ m.

COMMENTS—*Cordyceps owariensis* f. *viridescens* Uchiy. & Udagawa (Uchiyama & Udagawa 2002) and *C. brittlebankisoides* (Liu et al. 2001) are close to this species. The former is more similar to *M. guniujiangensis* in that both attack cicada nymphs and have similar stromata. However, they are quite different in other features.

The two stromata of *M. guniujiangensis* are confluent at their bases; the fertile parts are apically subulate with an acute, yellow, glabrous sterile tip. In comparison, the stromata of *C. owariensis* f. *viridescens* are solitary, simple or 3–4 branched, subulate apically with an acute, white, glabrous sterile tip. Furthermore, the perithecia and asci of *M. guniujiangensis* are longer (440–640 μm) than those of *C. owariensis* f. *viridescens* (180–300 μm), and the ascus cap of the new species is 2.8–3.0 μm in diameter and narrower (4.0–5.0 μm) than that of the latter.

There are obvious differences between *C. brittlebankisoides*, found on larvae of *Coleoptera*, and *M. guniujiangensis*, found on nymphs of *Homoptera*. The arrangement of their perithecia, the sizes of their perithecia and asci, and ascospores are all different. Additionally, the anamorphs of the three species are also different (TABLE 1).

TABLE 1. Morphological comparison of *Metacordyceps guniujiangensis* with allied species.

CHARACTER	SPECIES		
	<i>C. owariensis</i> f. <i>viridescens</i> (Uchiyama & Udagawa 2002)	<i>C. brittlebankisoides</i> (Liu et al. 2001)	<i>M. guniujiangensis</i> (this publication)
LOCATION	Amami–oshima Island, sw Japan.	Wawu Mountains, Sichuan, sw China	Guniujiang nature preserve, Anhui, se China
STROMA COLOR	greyish–green or dark herbage green	pale green	dark green
HOST	cicada nymph	scarabaeid larva	cicada nymph
FERTILE PART	acute, white, glabrous sterile tip	terminal tapering sterile tip	yellow, acute, glabrous sterile tip
PERITHECIUM (μm)	obliquely inserted, 440–640 × 180–320	vertically immersed, 406–531 × 170–220	obliquely inserted, 640–770 × 240–320
ASCUS (μm)	180–300 × 5–6.5	188–313 × 3	310–380 × 4.0–4.8
ASCUS CAP (μm diam)	4–5	3	2.8–3.0
ASCOSPORE shape. size	multiseptate, nonfragmenting	5.7–8.1 × 0.9 μm	multiseptate, nonfragmenting, 8–17 μm long
ANAMORPH	<i>Nomuraea</i> <i>owariensis</i>	<i>Metarhizium</i> <i>anisopliae</i> var. <i>majus</i>	<i>Metarhizium</i> aff. <i>cylindrosporum</i>

The culture (RCEF2001) of *M. guniujiangensis* (GNJ020527–04) is kept at the Research Center on Entomogenous Fungi, Anhui Agricultural University, China.

Metarhizium aff. *cylindrosporum* (Anamorph)

FIG. 2

Colonies on MEA grow moderately at 25°C after 14 days, 28.5–36.5 mm in diam., zonate with radiate veins, velutinous to farinose, light yellow green to light blue, with white floccose, margin. Reverse center light blue, with light crocus margin and radiating veins.

Hyphae septate, smooth-walled, hyaline, 1.5–2.5 µm wide. Conidiophores hyaline, smooth walled, cylindrical, arising from aerial hyphae, mostly branched,

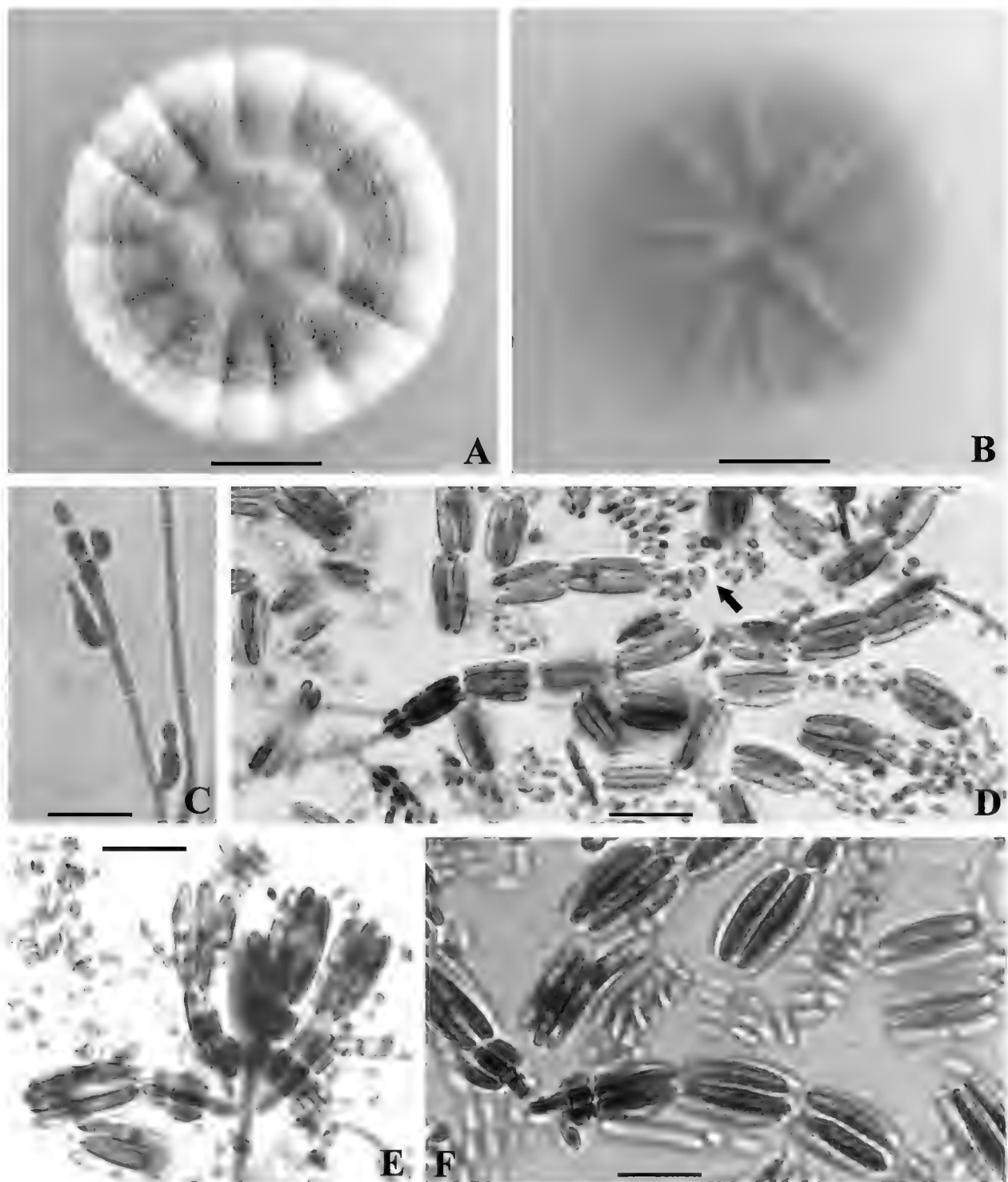


FIG. 2. *Metarhizium* aff. *cylindrosporum*, the anamorph of *Metacordyceps guniujiangensis*. A. A colony of *Metarhizium* aff. *cylindrosporum* on MEA (25°C, 14 d), bar = 10 mm; B. Reverse side, bar = 10 mm; C–F. Conidiophores and conidia: C, E, F, bar = 10 µm; D, bar = 20 µm. Note the small conidia in D (see arrow).

6.0–7.0 × 2.9–3.9 µm. Phialides solitary, or in a cluster of two to five, arising from short branches at the ends of conidiophores, clavate, 4.0–5.5 × 2.8–3.0 µm. Two types of conidia formed in long chains and united in a column structure, one celled, hyaline, smooth walled: small conidia are ovoid to ellipsoid, 5.0–6.5 × 3.0–4.0 µm (Fig. 2 D), and large conidia cylindric to banana-shaped, with both ends narrower, 14.5–24.0 × 3.0–4.0 µm (Fig. 2 D–F).

Colonies growing moderately, reaching 35.7–36.4 mm in diameter after 14 days on Czapek agar at 25°C; lawn thin, with ivory white margin; conidial masses light yellow green to light blue; reverse pale yellow. Conidiophores 5.0–6.3 × 2.0–3.75 µm. Phialides 4.0–6.3 × 2.2–3.0 µm. Two types of conidia: small conidia 5.0–10 × 2.0–3.3 µm, and large conidia 14.0–18.5 × 2.5–3.5 µm. Other characteristics similar to those on MEA.

A culture (RCEF2001) derived from ascospores of *M. guniujiangensis* (GNJ020527-04) is accessioned in the Research Center on Entomogenous Fungi, Anhui Agricultural University, China.

COMMENTS—Both *Metarhizium cylindrosporum* Q.T. Chen & H.L. Guo and *Metarhizium viridulum* (Tzean et al.) B. Huang & Z.Z. Li (Huang et al. 2004) grow on cicada nymphs and adults and have two types of conidia, close to *M. aff. cylindrosporum*, but they are quite different in their conidial size, the colour of conidial masses, and teleomorphic state (TABLE 2).

TABLE 2. Morphological and ITS sequence comparison of *Metarhizium* aff. *cylindrosporum* to allied *Metarhizium* species

CHARACTER	SPECIES			
	<i>M. cylindrosporum</i> (Guo et al. 1986; Shimazu 1989)	<i>M. viridulum</i> (Tzean et al. 1992)	<i>M. viridulum</i> (Huang et al. 2004)	<i>M. aff.</i> <i>cylindrosporum</i>
LOCATION	Guiyang, Guizhou, China; Ibaraki, Japan	Taipei, Taiwan	Anhui, China	Guniujiang nature preserve, Anhui, se China
CONIDIAL MASS (colour)	On PDA: light to dark green; pale grayish green to olive green	On MEA: greyish green to dull green	On cadaver: white to greyish green	On MEA: light yellow green to light blue
# OF CONIDIAL SHAPES	2	1	2	2
CONIDIAL SIZE (µm)	5.4 × 2.7; 17.2–19.7 × 2.5–3.7	14.4–19.4 × 3.8–4.4	4.2–9.0 × 4.0–5.5; 10.8–16.5 × 4.0–5.2	5.0–6.5 × 3.0–4.0; 14.5–24.0 × 3.0–4.0
% ITS SEQUENCE DIVERGENCE* (# bps)	9.3% (35) (type strain)	Unknown	8.2% (31)	0
TELEOMORPH	Unknown	Unknown	Unknown	<i>Metacordyceps</i> <i>guniujiangensis</i>

*NOTE: ITS divergence from *Metarhizium* aff. *cylindrosporum*

TAXONOMIC PLACEMENT OF THE CONIDIAL ISOLATE WITHIN *METARHIZIUM*—To determine the phylogenetic position of the anamorph of *M. guniujiangensis* in the *Metarhizium* genus, the sequence of strain RCEF2001 (GenBank No. AY913758) was compared with all available ITS sequences of *M. cylindrosporum* (ACCC30114), *M. viridulum* (AF368500), *Nomuraea rileyi* (AF368501), *M. anisopliae* var. *anisopliae* (AF135210), and *M. flavoviride* var. *flavoviride* (AF138270) retrieved from the GenBank Nucleotide database and analyzed by neighbour-joining, with *Beauveria bassiana* (AF347162) as outgroup (FIG. 3). The ITS sequence of the *M. guniujiangensis* anamorph differs from those of all the other *Metarhizium* spp., although *M. cylindrosporum* and *M. viridulum* are the closest with ITS sequence divergences of 9.3% (35 bp) and 8.2% (31 bp), respectively. The divergence between *M. cylindrosporum* and *M. aff. cylindrosporum* is even greater than that between *M. viridulum* and *M. aff. cylindrosporum*, although morphological differences between *M. cylindrosporum* and *M. aff. cylindrosporum* are less noticeable. The molecular evidence suggests that *M. aff. cylindrosporum* may be a new species.

ANAMORPHIC–TELEOMORPHIC RELATIONSHIPS—The size of amplified fragments spanning the ITS1-5.8S-ITS2 region of *Metacordyceps guniujiangensis* and *Metarhizium aff. cylindrosporum* (GenBank no. AY913757 and AY913758) are identical (534 bp). The sizes of ITS1, 5.8S rRNA and ITS2 in the ITS1-5.8S-ITS2 region are also identical at 187 bp, 158 bp and 189 bp, respectively. This molecular evidence confirms that the anamorph of *M. guniujiangensis* is *M. aff. cylindrosporum* identified based on the strain RCEF2001.

Discussion

Based on Sung's system (2007), the present specimen should be assigned to genus *Metacordyceps* in the clavicipitacean clade that includes the *Cordyceps* sensu lato species with *Metarhizium* anamorphs. A closely related species is *C. owariensis* f. *viridescens*, which also pathogenic on cicada nymphs. The hosts of more than 30 *Cordyceps* and related genera (about 8.5% of all known *Cordyceps* spp.) are reported as homopteran. In addition, among all the species of *Metacordyceps* with *Metarhizium* anamorphs, *C. brittlebankisoides* is closely related to the present species but its host is a scarabaeid.

In 1991, Liang et al. first established the relationship between *Metarhizium* and *Cordyceps*. Microcyclic conidiation confirmed *Metarhizium taii* as the anamorph of *Cordyceps taii* (= *Metacordyceps taii*). *Metacordyceps taii* and *M. guizhouense* are the same fungus based on their morphology and esterase isozyme profile (Liu et al., 1995). The name *M. guizhouense* has priority because it was published earlier than *M. taii*. However, Huang et al. (2005) suggested that *M. taii* should be treated as a synonym of *Metarhizium anisopliae* var. *anisopliae*.

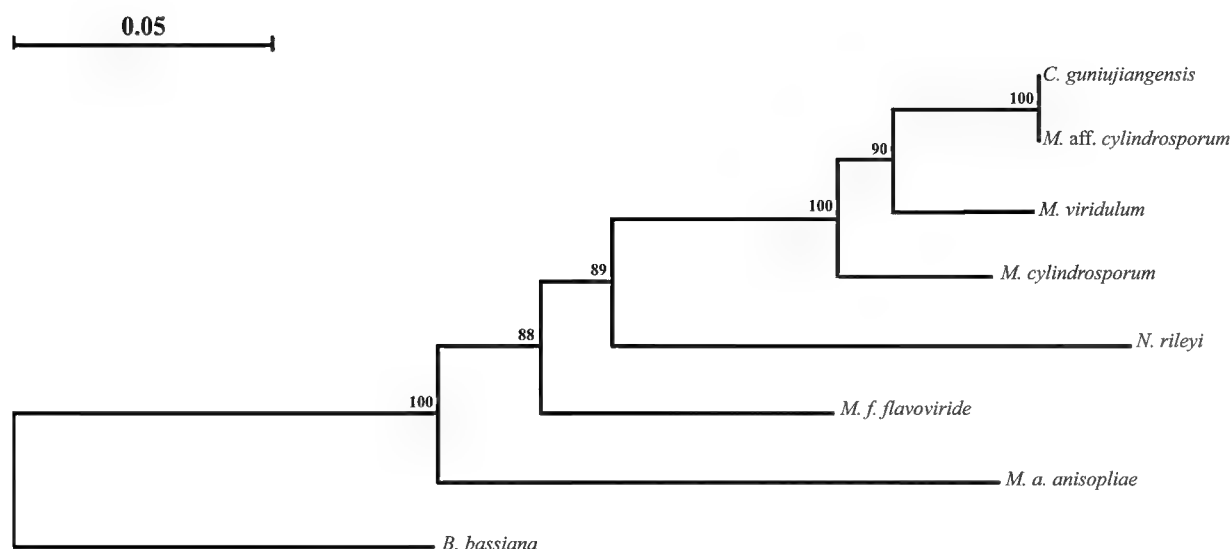


FIG. 3. Neighbour-joining tree based on ITS₁-5.8S-ITS₂ region sequence data from some *Metarhizium* spp. Values above the branches indicate bootstrap support.

based on sequence data of the ITS1-5.8S-ITS2 region, while its teleomorph was *C. taii*. Liu et al. (2001) confirmed *M. anisopliae* var. *majus* as the anamorph of *Cordyceps brittlebankisoides* (\equiv *Metacordyceps brittlebankisoides*) on the basis of shared morphological features between an isolate from stromal tissue and one from ascospores. Furthermore, ITS sequences of ribosomal DNA from the field-collected stroma were identical to those from the culture. In addition, Zhang et al. (2004) reported *Cordyceps campsosterni* (\equiv *Metacordyceps campsosterni*), a new pathogen of a wireworm, *Campsosternus auratus*, and the third *Cordyceps* species with a *Metarhizium* anamorph. Therefore, including the present species there are four reported species of *Metarhizium* anamorphs connected to *Metacordyceps* after phylogenetic revision of *Cordyceps* and the clavicipitaceous fungi.

Acknowledgments

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Literature cited

- Chen YQ, Wang N, Qu LH, Li TH, Zhang WM. 2001. Determination of the anamorph of *Cordyceps sinensis* inferred from the analysis of the ribosomal DNA internal transcribed spacers and 5.8S rDNA. *Biochem. Systemat. Ecol.* 29: 597–607.
- Curran J, Driver F, Ballard JWO, Milner RJ. 1994. Phylogeny of *Metarhizium*: Analysis of ribosomal DNA sequence data. *Mycol. Res.* 98: 547–552.
- Driver F, Milner RJ, Trueman WHA. 2000. Taxonomic revision of *Metarhizium* based on a phylogenetic analysis of rDNA sequence data. *Mycol. Res.* 104: 134–150.

- Guo HL, Ye BL, Yue YY, Chen QT, Fu CS. 1986. Three new species of *Metarhizium*. Acta Mycol. Sin. 5: 185–190.
- Huang B, Li CR, Li ZG, Fan MZ, Li ZZ. 2002. Identification the relationship between *Beauveria bassiana* and *Cordyceps bassiana*. Mycotaxon 81: 229–236.
- Huang B, Li CR, Humber RA, Hodge KT, Fan MZ, Li ZZ. 2005. Molecular evidence for the taxonomic status of *Metarhizium taii* and its teleomorph, *Cordyceps taii* (Hypocreales, Clavicipitaceae). Mycotaxon 94: 137–147.
- Huang B, Li SG, Li CR, Fan MZ, Li ZZ. 2004. Studies on the taxonomic status of *Metarhizium cylindrospora* and *Nomuraea viridula*. Mycosystema 23: 33–37.
- Kobayasi Y. 1941. The genus *Cordyceps* and its allies. Sci Rep Tokyo Bunrika Daigaku, Sect B, 5: 53–260.
- Kobayasi Y, Shimizu D. 1983. Iconography of vegetable wasps and plant worms (in Japanese). Hoikusha, Osaka.
- Leal SC, Bertoli DJ, Butt TM, Peberdy JF. 1994. Characterization of isolates of the entomopathogenic fungus *Metarhizium anisopliae* by RAPD–PCR. Mycol. Res. 98: 1077–1081.
- Li ZZ, Li CR, Huang B, Fan MZ, Lee MW. 1999. New variety of *Cordyceps gunnii* (Berk.) Berk. and its *Paecilomyces* anamorph. Korean J. Mycol. 26: 15–21.
- Liang ZQ. 1991. Anamorphs of *Cordyceps* and their determination. Southwest China J. Agr. Sci. 4: 1–8.
- Liang ZQ. 2007. Flora fungorum Sinicorum, Vol. 32, Cordyceps (in Chinese). Beijing, Science Press.
- Liang ZQ, Liu AY, Liu ZY. 1991. A new species of the genus *Cordyceps* and its *Metarhizium* anamorph. Acta Mycol. Sin. 10: 257–262.
- Liu ZY, Liang ZQ, Liu AY, Yao YJ, Hyde KD, Yu ZN. 2002. Molecular evidence for teleomorph–anamorph connections in *Cordyceps* based on ITS–5.8S rDNA sequences. Mycol. Res. 106: 1100–1108.
- Liu ZY, Liang ZQ, Whalley AJS, Yao YJ, Liu AY. 2001. *Cordyceps brittlebankisoides*, a new pathogen of grubs and its anamorph, *Metarhizium anisopliae* var. *majus*. J. Invertebr. Pathol. 78: 178–182.
- Liu ZY, Liang ZQ, Liu AY. 1995. Analysis of esterase isozyme bands and protein bands of *Metarhizium* spp. In W. Z. Tang (Ed.), Advanced research of Chinese young mycologists, pp. 131–135. Chongqing, China, Southwest Normal Univ. Press.
- Obornik M, Jirku M, Dolezel D. 2001. Phylogeny of mitosporic entomopathogenic fungi: is the genus *Paecilomyces* polyphyletic? Can. J. Microbiol. 47: 813–819.
- Shimazu M. 1989. *Metarhizium cylindrosporum* Chen et Guo (Deuteromycotina: Hyphomycetes), a causative agent of an epizootic on *Graptopsaltria nigrofuscata* Motchulski (Homoptera: Cicadidae). Appl. Entomol. Zool. 24: 430–434.
- Shimizu D. 1994. Color iconography of vegetable wasps and plant worms (in Japanese). Tokyo, Seibundo Shinkosha.
- Sung JM, Kim SH, Yoon CS, Sung GH, Kim YW. 1999. Analysis of genetic relationship of *Cordyceps militaris* in Korea by Random Amplified Polymorphic DNA. Korean J. Mycol. 27: 256–273.
- Sung GH, Hywel-Jones NL, Sung JM, Luangsa-ard JJ, Shrestha B, Spatafora JW. 2007. Phylogenetic classification of *Cordyceps* and the clavicipitaceous fungi. Stud. Mycol. 57: 5–59.
- Thompson JD, Higgins DG, Gibson TJ. 1994. Clustal W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position–specific gap penalties and weight matrix choice. Nucl. Acids Res. 22: 4673–4680.
- Tzean SS, Hsieh LS, Chen JL, Wu WJ. 1992. *Nomuraea viridulus*, a new entomogenous fungus from Taiwan. Mycologia 84: 781–786.

- Tzean SS, Hsieh LS, Chen JL, Wu WJ. 1993. *Nomuraea cylindrospora* comb. nov. *Mycologia* 85: 514–519.
- Uchiyama S, Udagawa S. 2002. *Cordyceps owariensis* f. *viridescens* and its new *Nomuraea* anamorph. *Mycoscience* 43: 135–141.
- Van de Peer Y, De Wachter R. 1994. TREECON for Windows: a software package for the construction and drawing of evolutionary trees for the Microsoft Windows environment. *Comput. Appl. Biosci.* 10: 569–570.
- Wang GD. 1995. *Cordyceps* spp., ecology, cultivation and application. Beijing, Scientific and Technical Documents Publishing House. 1–307.
- Zhang WM, Li TH, Chen YQ, Qu LH. 2004. *Cordyceps campsosterna*, a new pathogen of *Campsosternus auratus*. *Fung. Divers.* 17: 239–242.
- Zhao J, Wang N, Chen YQ, Li TH, Qu LH. 1999. Molecular identification for the asexual stage of *Cordyceps sinensis*. *Acta Sci. Nat. Univ. Sunyatseni* 38: 121–123.

A new rust species of *Coleosporium* on *Ligularia fischeri* from China

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Abstract – *Coleosporium zhuangii*, a new species on *Ligularia fischeri*, is described from China. Light and scanning electron microscopy observation indicate that this species is morphologically distinct from other known *Coleosporium* species in urediniospore-surface structure, urediniospore shape and size, and the teliospore arrangement in telia.

Key words – *Uredinales*, rust fungus, taxonomy

Introduction

The rust genus *Coleosporium* Lév. consists of about 100 species worldwide (Kirk et al. 2008). Most species are heteroecious and macrocyclic and produce spermogonia and aecia on the needles of *Pinus* and uredinia and telia on various woody and herbaceous angiosperms (Laundon & Rainbow 1971, Kaneko 1981). The genus is characterized by mature teliospores in the telia dividing into four-celled internal basidia with or without a sterile cell at their base; the upper part of teliospores is covered with a gelatinous layer, while the urediniospores are morphologically identical to aeciospores of a given species (Kaneko 1975, 1977, 1981; Hiratsuka & Kaneko 1975, Mims & Richardson 2005). In the taxonomic studies of *Coleosporium*, species delimitation has been based primarily upon the telial host range, teliospore arrangement in telia, presence or absence of a sterile cell at the base of four-celled basidia, urediniospore shape and size, and urediniospore and aeciospore surface structure (Hiratsuka 1960, Kaneko 1981). Approximately 58 species are currently reported in China (Tai 1979, Pan et al. 1991, Cao & Li 1999, Yan et al. 2006, Zhuang et al. 2006).

Coleosporium ligulariae Thüm. was originally based on a specimen on *Ligularia sibirica* (L.) Cass. collected in Siberia. In China, the rust fungus on *Ligularia* host plants has frequently been identified as *C. ligulariae*, and Tai (1979) and

Zhuang (2003) recorded this rust on nine *Ligularia* species, i.e., *L. dictyoneura*, *L. lapathifolia*, *L. stenocephala*, *L. tussilaginea* var. *formosana*, *L. duciformis*, *L. przewalskii*, *L. tangutica*, *L. deltoidea*, and *L. veitchiana*. Gao et al. (1996) and Cao & Li (1999), who described in detail the urediniospore and teliospore morphology of *C. ligulariae* on *L. przewalskii*, *L. veitchiana*, and *Ligularia* sp., stated that the urediniospore was subglobose or broadly ovate, densely verrucose with annulate verrucae, and with a reticulum-spot on the surface, while the teliospore was cylindrical or clavate, $40\text{--}80 \times 15\text{--}28 \mu\text{m}$, arranged in more than two layers. However, reports on the *Coleosporium* occurring on *Ligularia fischeri* (Ledeb.) Turcz. from China were scarce in literature. During a morphological and phylogenetic study of *Coleosporium* spp. in China, light and scanning electron microscopy was made of herbarium specimens on *L. fischeri*, *L. duciformis*, *L. franchetiana*, *L. przewalskii*, *L. veitchiana*, and *L. intermedia*. Our observations indicated that the urediniospores and teliospores of the rust on *Ligularia fischeri* differed morphologically from those on other species of *Ligularia* and other known *Coleosporium* species. The rust is illustrated and described as new.

Materials and methods

Materials

A total of 42 specimens parasitic on *Ligularia* sp. and *Saussurea* sp. were used for morphological observation. Dried specimens examined were loaned from the following institutions: the Herbarium Mycologicum Academiae Sinicae, Beijing (HMAS); Mycological Herbarium, Inner Mongolia Agricultural University, Hohhot (HIM); Mycological Herbarium, Beijing Forestry University, Beijing (HMBF); Mycological Herbarium, Northwest Agricultural & Forestry University, Yangling, Shaanxi (HMNWFC). Fresh specimens were collected from various locations during July to September from 2007 to 2009 in China.

Morphological observations

For light microscopy observations, urediniospores and hand sections of telia were mounted in a drop of lactophenol-cotton blue solution on a microscopic slide. For each specimen, about thirty spores were randomly chosen and observed for the selected morphological features, by using a DMIL Inverted Bio-microscope (Leica, German). The urediniospores and teliospores dimensions were measured by Microview MVC TWAIN Image Analyzer software. LM images were made by digitizing 35 mm color slides and converted them to black and white; Adobe Photoshop CS4 was used to adjust image contrast and to compose the plates.

In preparation for examination of urediniospore surface structure by SEM, urediniospores were attached on aluminum stubs covered with double-adhesive tapes, and then coated with platinum-palladium at 25 nm thick by a Hitachi SCD-005 Sputter Coater. The coated specimens were observed under a Hitachi S-4200 scanning electron microscope (Hitachi, Tokyo, Japan) operated at 10 or 15 kV. SEM images were captured using Quartz PCI Software ver. 4.0, and the plates were composed with Adobe Photoshop CS4.

Taxonomic description

Coleosporium zhuangii C.M. Tian & C.J. You, sp. nov.

FIG. 1

MYCOBANK MB516562

Spermogoniis et aeciis ignotis; urediniis hypophyllis, sparsis, rotundatis, 0.2–0.6 mm diam., mox nudis, pulverulentis, aurantiaco-flavis; urediniospores oblongo-ellipsoideis vel clavato-oblongis, 20.6–38.5 × 15.4–25.7 µm, episporio dense verrucosis, verrucis 0.6–1.0 µm latis, 0.3–0.6 µm altis; teliis hypophyllis, sparsis, rotundatis, 0.3–1.2 mm diam., rufo-aurantiacis; non-septatis teliosporis oblongo-cylindratis vel ellipsoideis, 50.9–84.6 × 15.4–32.0 µm,

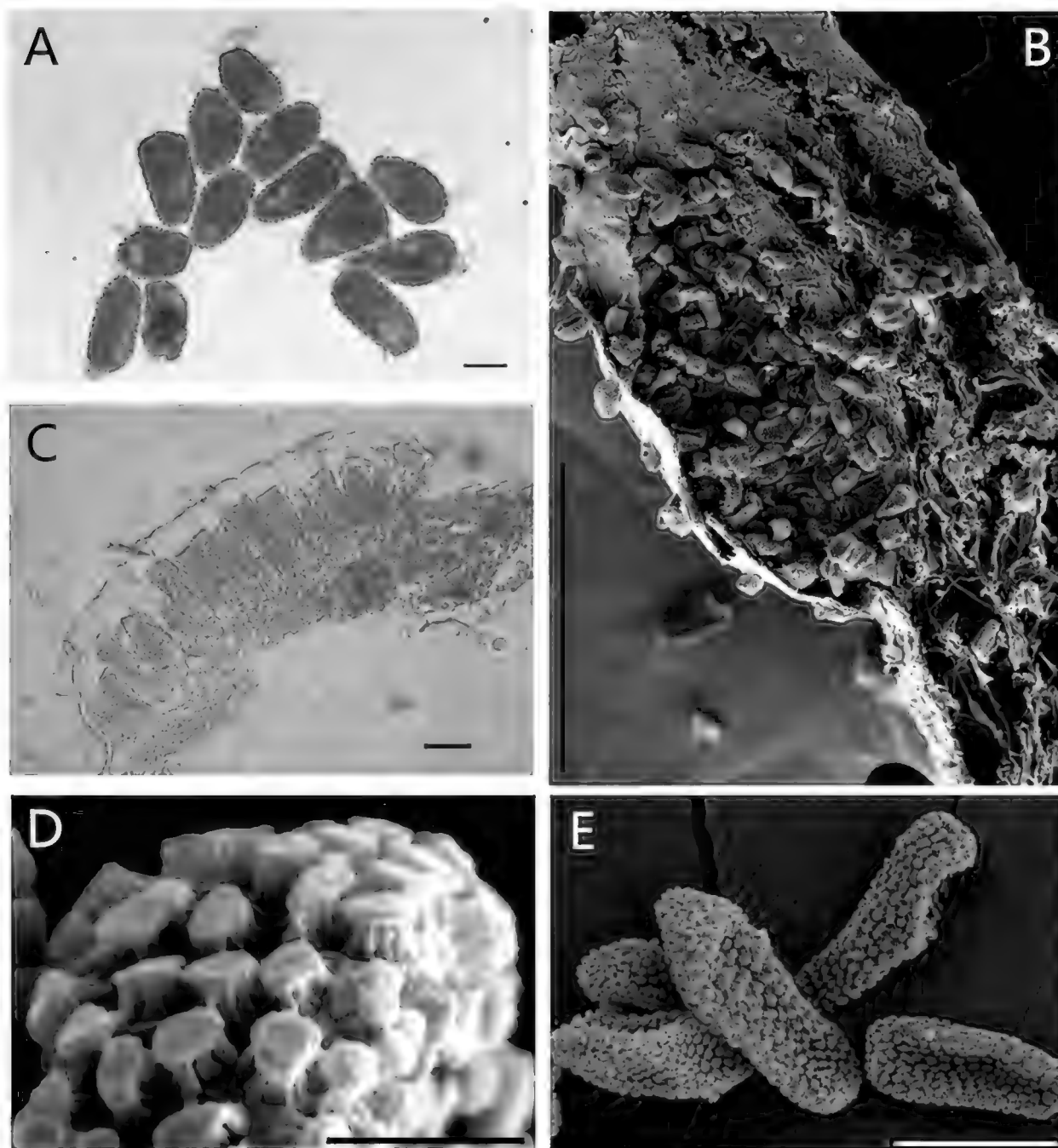


FIG. 1. *Coleosporium zhuangii* on *Ligularia fischeri* (HMAS-77787) A. Oblong-ellipsoid urediniospores observed by LM. (Bar = 10µm); B. Vertical section of telia (Bar = 20µm); C. Uredinia observed by SEM (Bar = 200µm); D. Urediniospores lacking a smooth or reticulum-like spot by SEM (Bar = 20µm); E. nailhead-like verrucae on urediniospore surface observed by SEM (Bar = 4µm).

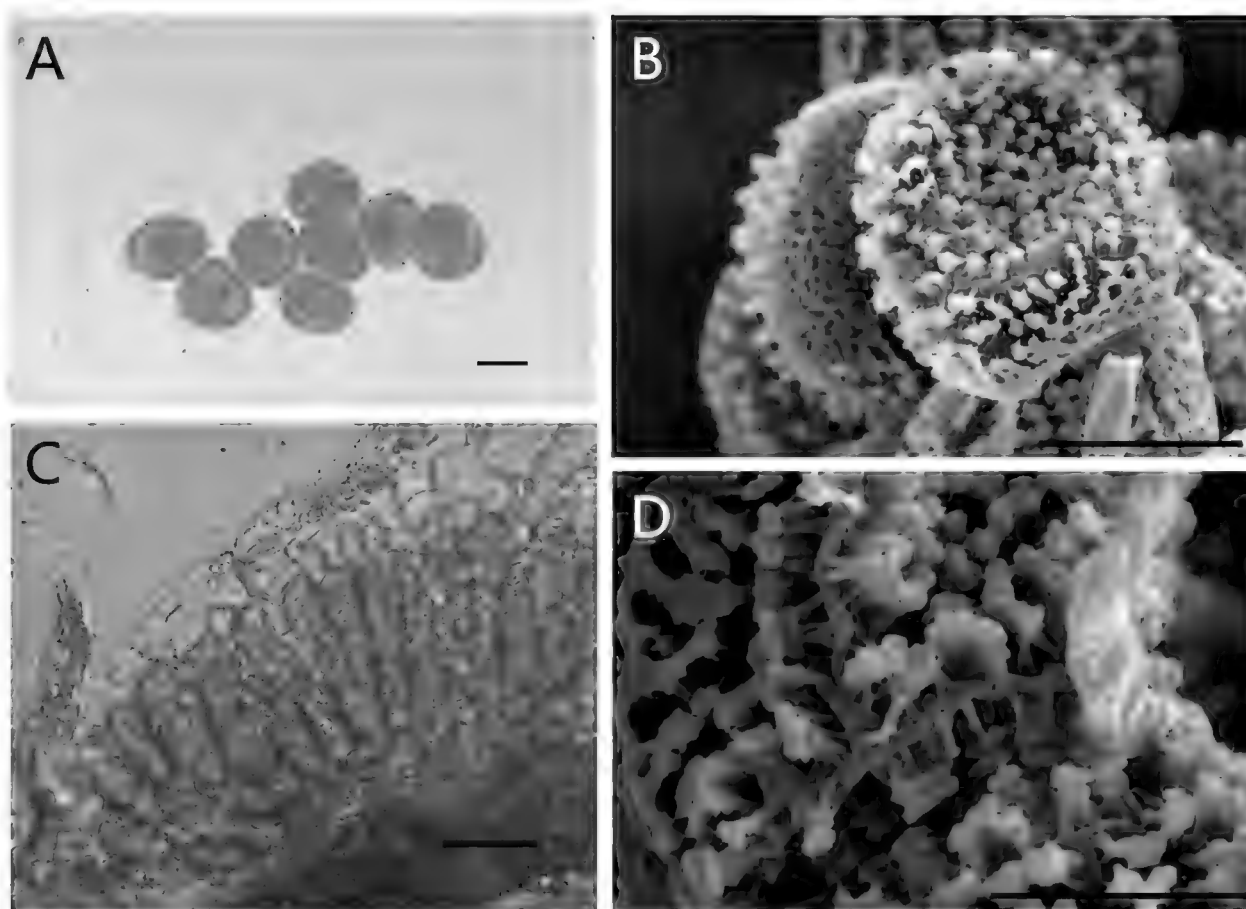


FIG. 2. *Coleosporium ligulariae* on *Ligularia duciformis* (HMAS-70985) A. Subglobose urediniospores observed by LM (Bar = 10µm); B. Vertical section of telia (Bar = 20µm); C. Urediniospores with a reticulum-like spot observed by SEM (Bar = 10µm); D. Annulate processes on urediniospore surface observed by SEM (Bar = 5µm).

tri-septatis basidiis 61.5–88.0 × 20.9–27.0 µm, transversim vel oblique septatis; membranis tenuis, hyalinis; basidiosporis ellipsoideis, 17.3–26.8 × 12.2–17.2 µm.

HOLOTYPE: in foliis *Ligulariae fischeri* (Compositae), Bailang, Provincia Mongolia Interior, Sina, Aug. 1991, J. Y. Zhuang, HMAS-77787, in Herbario Mycologico Academiae Sinicae, Beijing (HMAS) conservatus.

ETYMOLOGY: the species is named in honor of Dr. J.Y. Zhuang, the collector of the examined specimens.

Spermogonia and aecia unknown. Uredinia hypophyllous, scattered, rounded, 0.2–0.6 mm diam., soon naked, pulverulent, orange-yellow; Urediniospores oblong-ellipsoid or clavate-oblong, 20.6–38.5 × 15.4–25.7 µm, densely verrucose, without a smooth or reticulum-like spot, verrucae 0.6–1 µm broad, 0.3–0.6 µm high; Telia hypophyllous, scattered, 0.3–1.2 mm diam., orange-red; One-celled teliospores long-cylindrical or ellipsoid, 50.9–84.6 × 15.4–32.0 µm excluding gelatinous apical layer, four-celled internal basidia 61.5–88.0 × 20.9–27.0 µm, transversely or obliquely septate, mature teliospores or basidia arranged in a single layer, wall thin, hyaline; Basidiospores ellipsoid, 17.3–26.8 × 12.2–17.2 µm.

OTHER SPECIMENS EXAMINED: II, III on *Ligularia fischeri*, Wuchagou, Inner Mongolia, China, Aug. 1991, S.X. Wei & J.Y. Zhuang, HMAS-77785; Arxan, Inner Mongolia, China, Aug. 1991, J.Y. Zhuang, HMAS-77786; Jagdaq, Inner Mongolia, China, July 2000, J.Y. Zhuang, HMAS-82751; Arxan-yimin, Inner Mongolia, China, Aug. 1991, J.Y. Zhuang, HMAS-77788, 77789, 77797; Gyirong, Tibet, China, Sept. 1990, J.Y. Zhuang, HMAS-67451, 67456; Fuyuan, Heilongjiang, China, Aug. 2004, J.Y. Zhuang, HMAS-135993. Raohe, Heilongjiang, China, Sept. 2003, J.Y. Zhuang, HMAS-89239.

Discussion

The present species is clearly distinct from *C. ligulariae* by its oblong-ellipsoid urediniospore (FIG. 1 A) and unique urediniospore-surface structure. The urediniospores (FIG. 1 D, E) are densely verrucose, lacking a smooth or reticulum-like spot on their surface, and the verrucae of urediniospores are nail-headed to peltate, 0.3–0.6 μm in height, 0.6–1.0 μm in width, with stilt-like bases connected by narrow longitudinal ridges. The broad heads of the verrucae are somewhat flat, but granulate with tiny papillae. In contrast, the verrucae of the subglobose urediniospores of *C. ligulariae* (FIG. 2 A, B, D) with a smooth or reticulum-like spot on their surface, are annulate, 0.5–0.9 μm high, and 0.3–0.5 μm broad, with two-layer annuli and stilt-like bases, the broad uneven tops of the verrucae are bumpy with pitted warts. In addition, the urediniospore size (20.6–38.5 \times 15.4–25.7 μm) of *C. zhuangii* is larger than that of *C. ligulariae* (17.9–28.2 \times 12.8–23.1 μm ; 20.0–32.5 \times 17.5–22.5 μm ; Cao & Li 1999). Furthermore, the teliospores of *C. zhuangii* (FIG. 1 C) are generally arranged in a single layer, while those of *C. ligulariae* (FIG. 2 C) are frequently arranged in two or more layers.

Kaneko (1981) treated the *Coleosporium* on *Ligularia* spp. and *Saussurea* spp. in Japan as the same species, *C. saussureae* Thüm., through morphological observation and inoculation experiments. Thereafter, Kaneko et al. (1989) labeled a rust fungus on *Ligularia fischeri*, first recorded from Nepal, as *C. saussureae* based on the earlier (Kaneko 1981) taxonomic description. However, *C. saussureae* can be easily distinguished morphologically from the *C. ligulariae* on *Ligularia* spp. from Siberia by its somewhat larger urediniospores marked with reticulum-like spot on their surface and the basidia lacking a sterile cell. Gao et al. (1996) and Cao & Li (1999) suggested that the *C. ligulariae* from China is not synonymous to *C. saussureae* because of the differences in urediniospore size and surface structures. In *C. saussureae* the urediniospores are subglobose and 22.5–33.3 \times 15.4–23 μm (20–35 \times 14–22.5 μm , according to Cao & Li 1999), larger than those of *C. ligulariae*.

In this study, to some extent, the morphological features of *C. zhuangii* resemble those of *C. saussureae* on *Saussurea* spp. from China, but *C. zhuangii* differs in the shape of verrucae on urediniospore surface: *C. saussureae* has

globular urediniospores with a reticulum-like spot and thinner verrucae with cap-like tops.

The urediniospores of *C. campanulae* (Pers.) Lév. on *Adenophora* spp. and *Campanula* spp. are also have nail-headed verrucae that resemble those of *C. zhuangii*. However, *C. campanulae* can be distinguished from the present species by the smaller urediniospores with a greater number of verrucae per 100 μm^2 on the surface and the slender sterile cell at the base of telia. *Coleosporium campanulae* and *C. zhuangii* are also distinguished by having hosts exclusively in the *Campanulaceae* and the *Compositae*, respectively.

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Literature cited

- Cao ZM, Li ZQ. 1999. Rust fungi of the Qinling Mountains. China Forestry Publishing House. Beijing.
- Gao YH, Xue Y, Jiang JQ. 1996. Electron microscopic scanning observation of *Coleosporium* urediniospore surface marking. Journal of Northeast Forestry University 24(1): 102–106.
- Hiratsuka N. 1960. A provisional list of *Uredinales* of Japan proper and the Ryukyu Islands Sci. Bull. Agr. Home Econ. & Engin. Div. Univ. Ryukyus 7: 189–314.
- Hiratsuka N, Kaneko S. 1975. Surface structure of *Coleosporium* spores. Rept. Tottori. Mycol. Inst. 12: 1–13.
- Kaneko S. 1981. The species of *Coleosporium*, the causes of pine needle rusts in the Japanese Archipelago. Rept. Tottori Mycol. Inst. 19: 1–159.
- Kaneko S, Kakishima M, Ono Y. 1989. *Coleosporium* (*Uredinales*) from Nepal. Cryptogams of the Himalayas 2: 85–90.
- Kaneko S. 1977. Two new species of *Coleosporium* on *Adenophora* (*Campanulaceae*). Rept, Tottori. Mycol. Inst. 15: 21–28.
- Kaneko S. 1975. Two species of *Coleosporium* needle rusts on *Pinus pumila* (Pall.). Regell. Trans. Mycol. Inst. 16: 128–131.
- Laundon GF, Rainbow AF. 1971. *Coleosporium ipomoeae*. C.M.I. Descriptions of plant pathogenic fungi and bacteria. No. 282. Commonwealth Mycological Institute, Kew, UK.
- Mims CW, Richardson EA. 2005. Light and electron microscopy of teliospores and teliospore germination in the rust fungus *Coleosporium ipomoeae*. Canadian Journal of Botany 83: 451–458.
- Pan XR, Xue Y. 1991. Study on the problems and current situation of Chinese pine needle-rusts (*Coleosporium*). Journal of Northeast Forestry University 19(5): 84–94.

- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi, 10th ed. CABI International. London.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Academia Sinica, Beijing.
- Xue Yu, Shao LP, Cheng DS, He BZ. 1995. Taxonomic significance of symptom characteristics and aeciospores surface structure of pine needle rust. In: S Kaneko (ed.), The Fourth International IUFRO “Rust of Pines” Working Party Conference. Tsukuba: 23–26.
- Yan J, Wu PS, Shi ZW, Wu Y. 2006 A new record of *Coleosporium* (*Uredinales*) in China. *Mycosystema* 25(2): 327–328.
- Zhuang JY, Wei SX, Wang YC. 2003. Flora Fungorum Sinicorum. vol. 25. *Uredinales* (III). Science Press. Academia Sinica, Beijing.
- Zhuang JY, Wang SR. 2006. *Uredinales* of Gansu in Northwestern China. *Journal of Fungal Research* 4(3): 1–11.

The identity of type specimens in BP of some names in *Caloplaca*

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Abstract — Type materials held in BP of 16 specific and intraspecific names now placed in *Caloplaca* are appraised here. The names *Caloplaca balatonica*, *C. cerinella* f. *aggregata*, *C. lactea* var. *subimmersa*, *C. lactea* f. *densa*, *C. lallavei* f. *fulva*, *C. vitellinaria*, *C. vitellinoides*, and *Gasparrinia granulosa* f. *flavovirens* are reduced into synonymy of older names. We did not find any older synonyms for the names *Caloplaca brachyspora*, *C. flavovirescens* var. *persica*, *C. gyalolechiiiformis*, *C. hungarica*, and *C. servitiana*. The identity of the names *C. lojkae*, *C. variabilis* f. *densa*, and *C. variabilis* f. *geographica* is presently unclear. *Caloplaca pseudocitrina* is reduced into synonymy with *C. gyalolechiiiformis*. *Caloplaca servitiana* is considered to be different from another “black-fruited” corticolous species *C. oleicola*. Lectotypes are designated for *Caloplaca brachyspora*, *C. lojkae*, and *C. servitiana*.

Key words — Hungary, Mereschkowsky, Szatala, *Teloschistaceae*

Introduction

The Hungarian Natural History Museum in Budapest (BP) has a number of type collections of little-known lichen names. We selected type material of 16 specific and intraspecific names recently placed in *Caloplaca* (*Teloschistaceae*) for study. Authors of these names are Szatala (12), Mereschkowsky (1), Magnusson (1), Servít & Nádvorník (1) and Verseggy (1). Most of the names

are here reduced to synonymy of other names, but *Caloplaca brachyspora*, *C. flavovirescens* var. *persica*, *C. gyalolechiiformis*, *C. hungarica*, and *C. servitiana* represent well defined taxa.

Materials and methods

The following characters were investigated in type materials: character and colour of thalli, size and colour of apothecia, size of ascospores and width of septa; spore length / width ratios and septum width / spore length ratios were calculated. Other characters (e.g. excipular structure or size of vegetative diaspores) were studied for only some of the species. The measurements are given as (min.–)X±SD(–max.), where X = mean value and SD = standard deviation. Total numbers of measurements are given in brackets [n]. Photographs were made of both the collections studied and their labels; images are archived at: <http://botanika.bf.jcu.cz/lichenology/index.php?pg=5&func=cat&idx=4>.

The names

The accepted name for each taxon is presented in bold font.

1. *Caloplaca balatonica* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 275 (1956)

TYPE: [Hungaria, Balatonicum, Kővágóörs, ad rup. arenac., 6.8.1940, leg. V. Kőfaragó-Gyelnik]; BP_27077, holotype.

= *Caloplaca holocarpa* (Hoffm.) A.E. Wade

The type specimen possesses a very thin greyish (in spots yellowish) thallus and orange-red apothecia, c. 0.3–0.5 mm in diam. Ascospores are (11.0–)12.4±0.8(–13.75) × (6.5–)7.9±0.9(–9.0) µm in size [10]; spore length / width ratio: (1.3–)1.6±0.2(–1.9). Ascospore septa (5.0–)5.9±0.4(–6.25) µm wide [10]; septum width / spore length: (0.36–)0.47±0.04(–0.51). It grows on a siliceous substrate together with *Acarospora fuscata* (Nyl.) Arnold and *Candelariella vitellina* (Hoffm.) Müll. Arg. Its morphological and ecological characters agree well with *Caloplaca holocarpa* and we propose to reduce *C. balatonica* into synonymy with *C. holocarpa*.

2. *Caloplaca brachyspora* Mereschk., Lich. Ross. Exs., fasc. 22, no. 276 (1913)

LECTOTYPE, DESIGNATED HERE: Ukraine. Crimea: [ad lapides calcareas in sylvis ombrosis monasterii Kozma Demian, in Peninsula Taurica, leg. & det. C. Mereschowsky 1910], BP_27078 (KW, LE, isoelectotypes).

We examined syntypes (Mereschkowsky: Lichenes Rossiae Exsiccati 276) in BP, KW and LE and consider them identical. We selected the specimen in BP as a lectotype.

The syntypes superficially resemble *Caloplaca ferrarii* (Bagl.) Jatta; they have orange apothecia, c. 0.5–0.7 mm in diam., with paler margin on a very thin, ± endolithic, pale-grey thallus. Their ascospores are, however, distinctly shorter than in *C. ferrarii*; in the BP specimen, $(8.0-9.4 \pm 1.0(-11.25) \times (5.0-5.8 \pm 0.8(-7.5)) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.1-1.6 \pm 0.3(-2.05))$. Ascospore septa $(2.25-2.55 \pm 0.2(-3.0)) \mu\text{m}$ wide [10]; septum width / spore length: $(0.36-0.47 \pm 0.04(-0.51))$. Although this species is so far (for 100 years) known only from the type locality, it is well characterized and we have not found any other conspecific taxa.

3. *Caloplaca cerinella* f. *aggregata* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 274 (1956)

TYPE: Hungary. [Miskolc: ad Görömbölytapolca, supra corticem *Aceris tatarici*, leg. Fr. Hazslinszky]; BP_27140, holotype.

= *Caloplaca cerinella* (Nyl.) Flagey

The type material is typical *Caloplaca cerinella* with small yellow apothecia (< 0.3 mm in diam.), short asci (45–55 μm long) containing 14–15 ascospores; ascospores small, $(7.0-10.1 \pm 1.5(-12.0) \times (5.5-6.3 \pm 0.5(-7.0)) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.1-1.6 \pm 0.25(-2.0))$. Ascospore septa $(3.0-4.75 \pm 0.7(-5.5)) \mu\text{m}$ wide [10]; septum width / spore length: $(0.42-0.47 \pm 0.04(-0.54))$.

4. *Caloplaca flavovirescens* var. *persica* Szatala, in Rechinger, Ann. Naturh. Mus. Wien 50: 531 (1940)

TYPE: Iran. Prov. Khorasan: [in valle fluvii Atrek inter Shirvan et Budjnurd], 25.-27.6.1937, leg. K.H. Rechinger; BP_34075, holotype.

The type specimen has a yellow thallus of tall, convex areoles and orange apothecia, c. 0.3–0.5 mm in diam. Ascospores $(11.25-13.1 \pm 1.3(-15.0) \times (5.25-6.3 \pm 0.8(-8.0)) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.6-2.1 \pm 0.4(-2.9))$. Ascospore septa $(2.25-3.4 \pm 0.6(-4.25)) \mu\text{m}$ wide [10]; septum width / spore length: $(0.18-0.25 \pm 0.03(-0.29))$. The specimen occurs on calcareous rock with *Caloplaca bullata* (Müll. Arg.) Zahlbr., and *Candelariella oleaginescens* Rondon.

5. *Caloplaca gyalolechiiformis* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 276 (1956)

TYPE: [Hungaria. Pr. pag. Nógrád, in decl. m. Várhegy, siliceicola, 17.8.1937, leg. V. Köfaragó-Gyelnik]; BP_27571, holotype; BP_27569, 27570, isotypes.

= *Caloplaca pseudocitrina* Khodos. & Kudratov

TYPE: Tajikistan [Southern Tajikistan, Chormagzak pass, locality 'Schizbibi', alt. 1850 m, 1968, leg. I. Kudratov]; KW!, isotype.

Although the species superficially resembles *Caloplaca flavocitrina* (Nyl.) H. Olivier or some other species from the *Caloplaca citrina* group (sensu Vondrák et al. 2009), it is related to *C. crenulatella* (our unpublished molecular data). This is supported by its ascospore characters; in the type material, $(14.5-17.25 \pm 1.9(-19.5) \times (5.0-6.7 \pm 1.3(-9.5) \mu\text{m}$ in size [10]; spore length / width ratio: $(2.0-2.64 \pm 0.43(-3.41)$. Ascospore septa $(1.0-1.68 \pm 0.46(-2.5) \mu\text{m}$ wide [10]; septum width / spore length: $(0.06-0.09 \pm 0.03(-0.15)$. The type material was collected from volcanic rock with accompanying *C. crenulatella*.

The description of *Caloplaca pseudocitrina* is in accordance with *C. gyalolechiiiformis* (Kondratyuk et al. 2002) and its isotype in KW is obviously conspecific. Although the species is at present only known from Hungary (Szatala 1956) and Tajikistan (Kondratyuk et al. 2002), it is apparently a widely distributed species, not rare in arid regions of the Near and Middle East (our unpublished data).

6. *Caloplaca hungarica* H. Magn., Kungl. Vetenskaps- och Vitterhets-samhälles Handlingar, Sjätte Följden, ser. B 3: 28 (1944)

TYPE: [Hungaria. Com. Veszprém, in cortice ex Abiete pariete circa Juhász ház, pr. pag. Szent Ivan, alt. ca 200 m s m, 1 Marc. 1917, leg. F. Fóris, det. H. Magnusson]; BP_71731, holotype.

The holotype has deep red apothecia that are C+ purple (containing chlorinated anthraquinones) and forms small and thin thalli; individual thalli usually up to 5 mm in diam. and up to 150 μm thick. Apothecia c. $0.3-0.5(-0.7)$ mm in diam.; ascospores $(9.5-11.6 \pm 0.9(-12.5) \times (5.5-6.4 \pm 0.7(-7.5) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.5-1.8 \pm 0.19(-2.0)$. Ascospore septa $(3.25-4.3 \pm 0.9(-6.25) \mu\text{m}$ wide [10]; septum width / spore length: $(0.28-0.37 \pm 0.08(-0.53)$. It is a well characterized species and we have not found any other conspecific taxa.

Caloplaca ferruginea (Huds.) Th. Fr. differs in having apothecia 1–2 mm in diam. (Fletcher & Laundon 2009), larger thalli (often more than 1 cm in diam.) and larger ascospores, $(13-15-17 \times 8-8.5(-9) \mu\text{m}$ in size with septa $(5-7-8.5 \mu\text{m}$ thick (Magnusson 1944).

7. *Caloplaca lactea* var. *subimmersa* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 275 (1956)

TYPE: Hungary. [Budakalász: in monte Monalová chegy, alt. ca 270 m, ad saxa calcarea, 25.4.1926, leg. G. Timkó]; BP_27642, holotype; BP_27643, isotype.

= *Caloplaca lactea* (A. Massal.) Zahlbr.

The type material is typical *Caloplaca lactea* sensu Navarro-Rosinés & Hladun (1996) possessing an endolithic inconspicuous thallus, small pale orange

apothecia (up to 0.3 mm in diam.) and ascospores $(13.25-14.8 \pm 0.75(-16.0) \times (5.5-6.9 \pm 0.8(-8.25) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.75-2.2 \pm 0.3(-2.7)$. Ascospore septa $(2.25-2.8 \pm 0.3(-3.25) \mu\text{m}$ wide [10]; septum width / spore length: $(0.16-0.19 \pm 0.02(-0.23)$. Apothecia are sessile but low and impressed among crystals of limestone; the name *subimmersa* probably reflects this appearance.

8. *Caloplaca lactea* f. *densa* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 275 (1956)

TYPE: Hungary. [Szentes, ad murum, 1.6.1939, leg. J. Olsz; BP_27615, holotype.

= *Caloplaca crenulatella* (Nyl.) H. Olivier

The holotype is conspecific with *C. crenulatella*; apothecia up to 0.5 mm in diam., pale orange with yellowish outer exciple, thallus inconspicuous consisting of small yellow areoles around apothecia, ascospores $(14.0-15.3 \pm 0.8(-16.25) \times (6.0-6.5 \pm 0.7(-8.0) \mu\text{m}$ [10], length / width ratio $(2.0-2.4 \pm 0.2(-2.7)$, septum $(2.25-2.7 \pm 0.25(-3.0) \mu\text{m}$ [10], septum width / spore length ratio $(0.14-0.17 \pm 0.03(-0.21)$. The type specimen grows on concrete, a typical substrate for *C. crenulatella*; accompanying species are *C. decipiens* (Arnold) Blomb. & Forssell, *C. soralifera* Vondrák & Hrouzek, and *C. teicholyta* (Ach.) J. Steiner.

9. *Caloplaca lallavei* f. *fulva* Szatala, in Versegly, Studia bot. hung. 9: 24 (1974), nom. nud.

= *Caloplaca erythrocarpa* (Pers.) Zwackh

The name cannot be formally typified as it was never validly published by Szatala; it appears only in Versegly (1974) as a nomen nudum. The material in BP consists of three envelopes; BP_27659, BP_27660 and BP_27661. All of them are conspecific with *Caloplaca erythrocarpa*; they form white thalli, up to 1 mm in diam., apothecia are deep red (strong C+ purple reaction), very low and small (up to 0.5 mm in diam.), vegetative diaspores (blastidia, etc.) are absent. Ascospores $(10.75-12.7 \pm 1.2(-14.0) \times (6.0-6.7 \pm 0.5(-7.5) \mu\text{m}$ [10], length / width ratio $(1.5-1.9 \pm 0.3(-2.3)$, septum thin, $(2.75-3.7 \pm 0.6(-4.75) \mu\text{m}$ [10], septum width / spore length ratio $(0.25-0.29 \pm 0.03(-0.35)$. The specimens grow on calcareous rock with accompanying *Caloplaca variabilis* s.l., *Candelariella aurella* (Hoffm.) Zahlbr., *Caloplaca oasis* (A. Massal.) Szatala, and *C. polycarpa* (A. Massal.) Zahlbr.

10. *Caloplaca lojkae* Servít & Nádv., Věstn. Král. Čes. spol. Nauk, třída mat.-přír. 1935: 20 (1936)

LECTOTYPE, DESIGNATED HERE: Romania. [supra lapides inundatos micaceo-schistosis in rivulo vallis "Riu sor" infra alpem Retezat, comit. Hunyad in Transylvania, leg.

H. Lojka]; H. Lojka: Lich. Reg. Hung. Exs., 121; BP_27697 sub *Lecanora aurantiaca* f. *inalpina*.

The specimen resembles some samples of *Caloplaca percrocata* (Arnold) J. Steiner but it has much smaller ascospores and lacks a cortex; it may represent a rare, separate species. It possesses a pale grey smooth rimose thallus and brown-red apothecia, C+ slightly red. Apothecia up to 0.6 mm in diam., zeorine, with outer thalline exciple c. 80–100 µm thick and true exciple c. 40–60 µm thick. Inner part of true exciple and lower hypothecium ± paraplectenchymatous. Ascospores (10.25–)11.25±0.8(–12.5) × (5.75–)6.9±0.9(–8.75) µm [10], length / width ratio (1.3–)1.6±0.2(–1.9), septum (2.75–)3.5±0.6(–4.5) µm [10], septum width / spore length ratio (0.25–)0.31±0.06(–0.41).

Two specimens are mentioned in the protologue; “H. Lojka: Lich. Reg. Hung. Exs., 121” is the first one with a notice “Nation. Mus. Budapest”. This is the one designated above as lectotype.

11. *Caloplaca servitiana* Szatala, in Reehinger, Denkschr. Akad. Wiss. Math. Nat. wiss. Kl. Wien 105: 51 (1943)

LECTOTYPE, DESIGNATED HERE: Greece. [Samos: M. Kerki, ca 800 m s. m., supra corticem]; 18.6.1932, leg. K. H. Reehinger, BP_34015 (W_9203, isolectotype!).

The specimen represents a black-fruiting, corticolous *Caloplaca* without anthraquinones. It has a dark grey thin thallus not producing any vegetative diaspores and brown-black apothecia, up to 1 mm in diam. True exciple well developed, grey when wet, 60–100 µm thick; thalline exciple (80–100 µm thick) usually hidden on lower side of apothecial margin. Some old apothecia convex with receding margins. Pigments in epihymenium and outer true exciple correspond with Sedifolia-grey (sensu Meyer & Printzen 2000). Ascospores (13.75–)14.7±0.6(–15.5) × (5.5–)6.4±0.5(–7.25) µm [10], length / width ratio (2.1–)2.3±0.2(–2.7), septum (5.5–)6.6±1.0(–8.25) µm [10], septum width / spore length ratio (0.37–)0.45±0.07(–0.55). According to the ITS sequence of fresh material conspecific with *C. servitiana* (Greece. Pindos Mts: Dasiko Khorio, T. Spribille 16225!, duplicate in CBFS), the species does not belong to the monophyletic *Pyrenodesmia* group of the “black-fruiting” species.

Apart from the material in BP, another syntype was found in W (9203). The specimen in W is a small thallus of *Caloplaca servitiana* which agrees morphologically with the sample in BP; it is accompanied by *Lecidella elaeochroma* (Ach.) M. Choisy and *Rinodina exigua* (Ach.) Gray.

Caloplaca oleicola (J. Steiner) Van den Boom & Breuss, another black-fruiting, corticolous *Caloplaca* species, is clearly distinct from *C. servitiana*. Its type specimen (Italy. Liguria: Rojatal, on bark of *Olea europaea*, 1907, Brunnthaller; WU, holotype!) has a thin white thallus and biatorine apothecia with prosoplectenchymatous true exciple and without a thalline exciple.

Pigments in outer exciple and epihymenium are anthraquinones (K+ strongly violet, K \rightarrow HCl+ yellow, N+ orange, N \rightarrow K+ violet-blue, N \rightarrow K \rightarrow HCl+ yellow, C-). Ascospores $(11.0-12.8 \pm 1.0 (-14.0) \times (6.5-7.25 \pm 0.5 (-8.0) \mu\text{m}$ [10], length / width ratio $(1.6-1.8 \pm 0.1 (-1.9)$, septum $(4.25-5.2 \pm 0.7 (-6.5) \mu\text{m}$ [10], septum width / spore length ratio $(0.32-0.4 \pm 0.04 (-0.46)$. Some ascospores are of a sand-glass type (see Figs 6–8 in Navarro-Rosinés et al. 2000), with widened wall up to 1 μm . Some other details of this type specimen are present in van den Boom & Etayo (1995).

12. *Caloplaca variabilis* f. *densa* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 275 (1956)

TYPE: Hungary. [Comit. Borsod: Diósgyőr, ad saxa calcarea, leg. Fr. Hazslinszky]; BP_27988, holotype.

= *Caloplaca variabilis* s. lat. (the same concept was used in Verseghe 1988, 1994)

The type material belongs in the “black-fruiting” *Pyrenodesmia* group, but its exact identification is difficult, as it belongs to the *Caloplaca variabilis* complex, which has been considered heterogeneous (Muggia et al. 2008; our unpublished data).

The specimen has a grey thallus, 100–300 μm thick with Sedifolia-grey pigment (K+ violet) in the cortical tissue. Apothecia up to 1 mm in diam., in dense groups, often with angular margins. Disc brown, rarely white pruinose, true exciple dark brown (containing K+ Sedifolia-grey), 50–80 μm thick and thalline exciple 80–120 μm thick, \pm white pruinose. Ascospores $(11.0-13.4 \pm 1.9 (-17.75) \times (6.0-6.6 \pm 0.6 (-8.0) \mu\text{m}$ [10], length / width ratio $(1.5-2.0 \pm 0.4 (-3.0)$, septum $(2.5-2.8 \pm 0.25 (-3.25) \mu\text{m}$ [10], septum width / spore length ratio $(0.15-0.21 \pm 0.03 (-0.24)$.

13. *Caloplaca variabilis* f. *geographica* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 275 (1956)

TYPE: Hungary. [Comit. Pest. Margitliget: in monte Oszoly, alt. ca 300 m, ad saxa calcarea, 13.4.1925, leg. V. Gyelnik]; BP_27990, holotype.

= *Caloplaca variabilis* s. lat.

The type material represents another species from a “black-fruiting” *Pyrenodesmia* group; its exact identification is difficult for the same reason as with *Caloplaca variabilis* f. *densa*.

The specimen possesses a grey thallus, 100–250 μm tall with presence of K+ pigment Sedifolia-grey in cortical tissue. Individual thalli (c. 1 cm in diam.) are delimited by a thin black prothallus line (probably the reason for the epithet *geographica*). Apothecia low, up to 0.6 mm in diam., disc and true exciple blackish (containing K+ Sedifolia-grey), thalline exciple grey, \pm white pruinose. Ascospores $(11.5-14.0 \pm 2.2 (-17.0) \times (5.0-6.7 \pm 0.8 (-7.75) \mu\text{m}$ [10],

length / width ratio $(1.6-2.1 \pm 0.3(-2.6))$, septum $(2.5-3.2 \pm 0.4(-3.5)) \mu\text{m}$ [10], septum width / spore length ratio $(0.2-0.23 \pm 0.02(-0.26))$.

14. *Caloplaca vitellinaria* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 276 (1956)

TYPE: [Hungaria. Comit. Zala: prope pagum Szigliget, in m. Szigliget, ad muros basalticos ruinae, 20.7.1933, leg. V. Gyelnik, det. Ö. Szatala]; BP_28055, holotype.

= *Caloplaca holocarpa* (Hoffm.) A.E. Wade (the same concept was used in Arup 2009: 123)

Morphological characters of the type agree with *Caloplaca holocarpa*. Orange-red apothecia (0.2–0.7 mm in diam.) are densely aggregated on inconspicuous thallus; ascospores $(12.5-13.7 \pm 0.8(-15.0)) \times (6.5-7.8 \pm 0.9(-9.75)) \mu\text{m}$ in size [10]; spore length / width ratio: $(1.5-1.8 \pm 0.16(-2.2))$. Ascospore septa $(4.5-5.9 \pm 0.7(-6.75)) \mu\text{m}$ wide [10]; septum width / spore length: $(0.32-0.43 \pm 0.05(-0.48))$. Growing on siliceous stone together with *Candelariella vitellina*; this matches the ecology of *C. holocarpa*.

Szatala (1956) described *C. vitellinaria* as a lichenicolous lichen on *Candelariella vitellina*. According to our observations, apothecia of *Caloplaca* usually grow very close to *Candelariella* squamules, but sometimes alone. Thus, it cannot be considered an obligate lichenicolous lichen, such as *Caloplaca grimmiae* (Nyl.) H. Olivier on *Candelariella*.

15. *Caloplaca vitellinoides* Verseghe, Studia bot. hung. 8: 49 (1973)

TYPE: Hungary. [ad rupes andesiticas toffineas pr. pag. Szentendre, comit. Pest, cca 160 m. s. m., 10.10.1925, leg. G. Timkó, det. Ö. Szatala]; BP_28057, holotype.

= *Caloplaca crenulatella* (Nyl.) H. Olivier

The holotype of *Caloplaca vitellinoides* is conspecific with *C. crenulatella*; apothecia (0.2–0.45 mm in diam.) pale orange with yellowish outer exciple, thallus inconspicuous, ascospores $(14.25-15.4 \pm 0.75(-16.75)) \times (4.75-6.0 \pm 0.2(-7.75)) \mu\text{m}$ [9], length / width ratio $(1.8-2.6 \pm 0.6(-3.5))$, septum $(2.0-2.5 \pm 0.7(-4.25)) \mu\text{m}$ [9], septum width / spore length ratio $(0.1-0.16 \pm 0.04(-0.28))$.

16. *Gasparrinia granulosa* f. *flavovirens* Szatala, Ann. Hist.-Nat. Mus. Natl. Hungarici, s.n. 7: 277 (1956)

TYPE: Hungary. [Veszprém: in decl. montis Szent Benedekhegy, alt. ca 300 m, ad saxa calcarea, 12.8.1925, leg. V. Gyelnik]; BP_28523, holotype.

= *Caloplaca granulosa* (Müll. Arg.) Jatta (the same concept was used in Verseghe 1988, 1994)

The specimen is conspecific with *Caloplaca granulosa*. It possesses orbicular yellow thalli, somewhat similar to *Candelariella medians* (Nyl.) A.L. Sm., but it

contains anthraquinones. Marginal lobes are small, 0.1–0.8 mm wide; areoles in the thallus centre are entirely covered by blastidia, c. 50–300 µm in diam. In the holotype, *C. granulosa* grows together with *C. saxicola* s.l.

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Toby Spribille kindly provided his herbarium material and reviewed the manuscript. Linda in Arcadia and Shaun Pennycook made lots of valuable comments on the manuscript. Our research was supported by the Hungarian Scientific Research Fund (OTKA T47160) and the Grant Agency of the Academy of Sciences of the Czech Republic (KJB 601410701).

Literature cited

- Arup U. 2009. The *Caloplaca holocarpa* group in the Nordic countries, except Iceland. *Lichenologist* 41: 111–130.
- van den Boom PPG, Etayo J. 1995. A new epiphytic species of the lichen genus *Caloplaca* from southwestern Europe. *Mycotaxon* 56: 125–132.
- Fletcher A, Laundon J. 2009. *Caloplaca*. In: CW Smith et al. (eds), *The lichens of Great Britain and Ireland*. pp. 245–273. The British Lichen Society, London.
- Kondratyuk S, Kärnefelt I, Kudratov I, Khodosovtsev A. 2002. Two new species of *Caloplaca* from Tadzikistan, Central Asia. – *Nordic Journal of Botany* 22(5): 633–640.
- Meyer B, Printzen C. 2000. Proposal for a standardized nomenclature and characterization of insoluble lichen pigments. *Lichenologist* 32(6): 571–583.
- Magnusson AH. 1944. Studies in the *ferruginea*-group of the genus *Caloplaca*. *Kunglia Vetenskaps- och Vitterhets-samhälles Handlingar, Sjätte Följden*, ser. B 3: 3–71.
- Muggia L, Grube M, Tretiach M. 2008. A combined molecular and morphological approach to species delimitation in black-fruited, endolithic *Caloplaca*: high genetic and low morphological diversity. *Mycological Research* 112: 36–49.
- Navarro-Rosinés P, Gaya E, Roux C. 2000. *Caloplaca calcitrapa* sp. nov. (*Teloschistaceae*) un nuevo liquen saxícola-calcícola mediterráneo. *Bulletin de la Société Linnéenne de Provence* 51: 145–152.
- Navarro-Rosinés P, Hladun NL. 1996. Les especies saxícola-calcícolas del grupo de *Caloplaca lactea* (*Teloschistaceae*, líquenes), en las regiones mediterránea y medioeuropea. *Bulletin de la Société Linnéenne de Provence* 47: 139–166.
- Servít M, Nádvorník J. 1936. Flechten aus der Čechoslovakei V. Karpatho-Russland. *Věstn. Král. Čes. spol. Nauk, třída mat.-přír.* 1935: 1–24.
- Szatala Ö. 1940. Lichenes. In: KH Rechinger (ed.), *Ergebnisse einer botanischen Reise nach dem Iran, 1937*. *Ann. Naturh. Mus. Wien* 50: 521–533.
- Szatala Ö. 1943. Lichenes. In: KH Rechinger (ed.), *Flora Aegaea, flora der Inseln u. Halbinseln des Aegeischen Meeres*. *Denkschr. Akad. Wiss. Math. Nat. wiss. Kl. Wien* 105(1): 16–58.
- Szatala Ö. 1956. Neue Flechten. *V. Ann. Hist.-Nat. Mus. Natl. Hungarici*, ser. nov. 7: 271–282.
- Verseghe K. 1973. *Caloplaca*-Arten in Ungarn. (Hazai *Caloplaca*-fajok). *Studia bot. hung.* 8: 33–64.
- Verseghe K. 1974. Nachtrag II. zum “Typenverzeichnis der Flechtensammlung in der Botanischen Abteilung des Ungarischen Naturwissenschaftlichen Museums”. *Studia bot. hung.* 9: 23–29.

- Verseghy K. 1988. Magyarországi zuzmóflóra revíziójának eredményei. (Ergebnisse der Revision der Flechtenflora von Ungarn). Bot. Közlem. 74–75(1–2): 31–46 (1987–88).
- Verseghy K. 1994. Magyarország zuzmóflórájának kézikönyve. (The lichen flora of Hungary). Magyar Természettudományi Múzeum, Budapest, 415 pp.
- Vondrák J, Říha P, Arup U, Søchting U. 2009. The taxonomy of the *Caloplaca citrina* group (*Teloschistaceae*) in the Black Sea region; with contributions to the cryptic species concept in lichenology. Lichenologist 41: 571–604.

A new species and a new record of *Erysiphaceae* from China

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Abstract—The new species *Podosphaera setacea* on *Crataegus sanguinea* (Rosaceae) in China, intermediate between species of *Podosphaera* sect. *Podosphaera* and sect. *Sphaerotheca*, is described, illustrated, and compared with the morphologically similar species *Podosphaera tridactyla*, *P. ferruginea* and *P. spiraeae*. A new record for China, *Erysiphe buhrii*, is recorded on the new host species *Stellaria dichotoma* var. *lanceolata*.

Key words—*Erysiphales*, powdery mildews, taxonomy

Introduction

Several interesting specimens of powdery mildew fungi were collected in Chifeng City, Inner Mongolia Autonomous Region, in the north of China in 2008. One of them was a species of *Podosphaera* Kunze on *Crataegus sanguinea* resembling an immature collection of *P. tridactyla* (Wallr.) de Bary (*Podosphaera* sect. *Podosphaera*) with each appendage bearing a simple, unbranched apex. However, asci and ascospores were fully developed and mature, suggesting that the appendages in this species remain unbranched. Furthermore, *P. tridactyla* does not occur on *Crataegus* spp. The Chinese species on *Crataegus* has been compared with other *Podosphaera* species on *Rosaceae* and was determined to be a distinct, new species. Another specimen represented a new record for China, viz. *Erysiphe buhrii* on *Stellaria dichotoma* var. *lanceolata*, a new host for this species.

Materials and methods

Material was mounted in distilled water and examined using 100X oil immersion objectives (bright field and phase contrast), but without any staining, using standard light microscopy. For each collection, 60 measurements of conidia and other structures were made in water, with extremes given in parentheses.

Collections were deposited in the Mycological Herbarium of the Chifeng College, Inner Mongolia, China ("CFSZ") and the Herbarium of Martin-Luther-University, Halle (Saale), Germany (HAL).

Taxonomy

(1) *Podosphaera setacea* T.Z. Liu & H.M. Tian, sp. nov.

FIG. 1

MYCOBANK MB 515405.

Podosphaerae tridactylae similis, sed appendicibus chasmotheciorum simplicibus, non ramosis.

ETYMOLOGY: derived from the stiff, setiform chasmothecial appendages.

MYCELIA on stems and leaves, amphigenous, forming distinct white patches or irregular coats, persistent or subpersistent, strongly infected stems frequently disfigured and distorted. HYPHAE 5–7(–9.5) μm wide, hyaline, smooth, thin-walled. APPRESSORIA nipple-shaped. CONIDIOPHORES erect, 48–214 μm long, foot-cells cylindrical, straight or somewhat flexuous, (32–)70–112 \times 9–13 μm , basal septum often somewhat distant from the branching point of the mycelium, 6–16 μm . CONIDIA in chains, ellipsoid-ovoid or doliiform, with fibrosin bodies, 17.5–35 \times 10–17.5 (average 26 \times 14) μm . CHASMOTHECIA on stems, gregarious, dark brown, globose or subglobose, (55–)60–80(–90) (average 71) μm diam. PERIDIUM CELLS irregularly polygonal, 10–27.5 μm diam. APPENDAGES 3–8, arising from the upper half of the chasmothecium, not mycelium-like, setiform, simple, straight or curved, (0.5–)1–2(–3) times as long as the chasmothecial diam., (30–)70–150(–210) μm long, 7–11 μm wide near the base, narrower towards the apex, 5–7.5 μm wide at the tips, thick-walled, smooth or rarely verruculose, 3–7(–9)-septate, brown throughout or in the basal half, paler towards the apex, apical portion hyaline. ASCI subglobose or ovate-saccate, sessile or short-stalked, 50–80 \times 37.5–70 (average 66 \times 56.5) μm . ASCOSPORES 8 per ascus, ellipsoid or ovoid, 15–21 \times 10–16 (average 19 \times 13 μm) μm .

SPECIMEN EXAMINED: CHINA. INNER MONGOLIA, Chifeng City, Bairin Right Banner, Saihanwula National Nature Reserve, Rongsheng, on living leaves and stems of *Crataegus sanguinea* Pall. (Rosaceae), 20 Jul. 2008, T.Z. Liu, C. Sun & J. Zhang, CFSZ 1230 (holotype); HAL 2324 F (isotype).

COMMENTS: On the basis of terminal, setiform, septate, pigmented chasmothecial appendages, the new species on *Crataegus sanguinea* in China appears close to *Podosphaera tridactyla*, a common, widespread species on hosts of *Prunus* s. lat., although appendage apices of the former fungus are consistently unbranched. Species with unbranched appendages usually are placed in *Podosphaera* sect. *Sphaerotheca* (Lév.) U. Braun & Shishkoff. With regard to the characters of the chasmothecial appendages, *P. setacea* is intermediate between *Podosphaera* sect. *Podosphaera* and sect. *Sphaerotheca*, although this species is rather allied to *P. tridactyla*. *Podosphaera leucotricha* is another species of *Podosphaera*

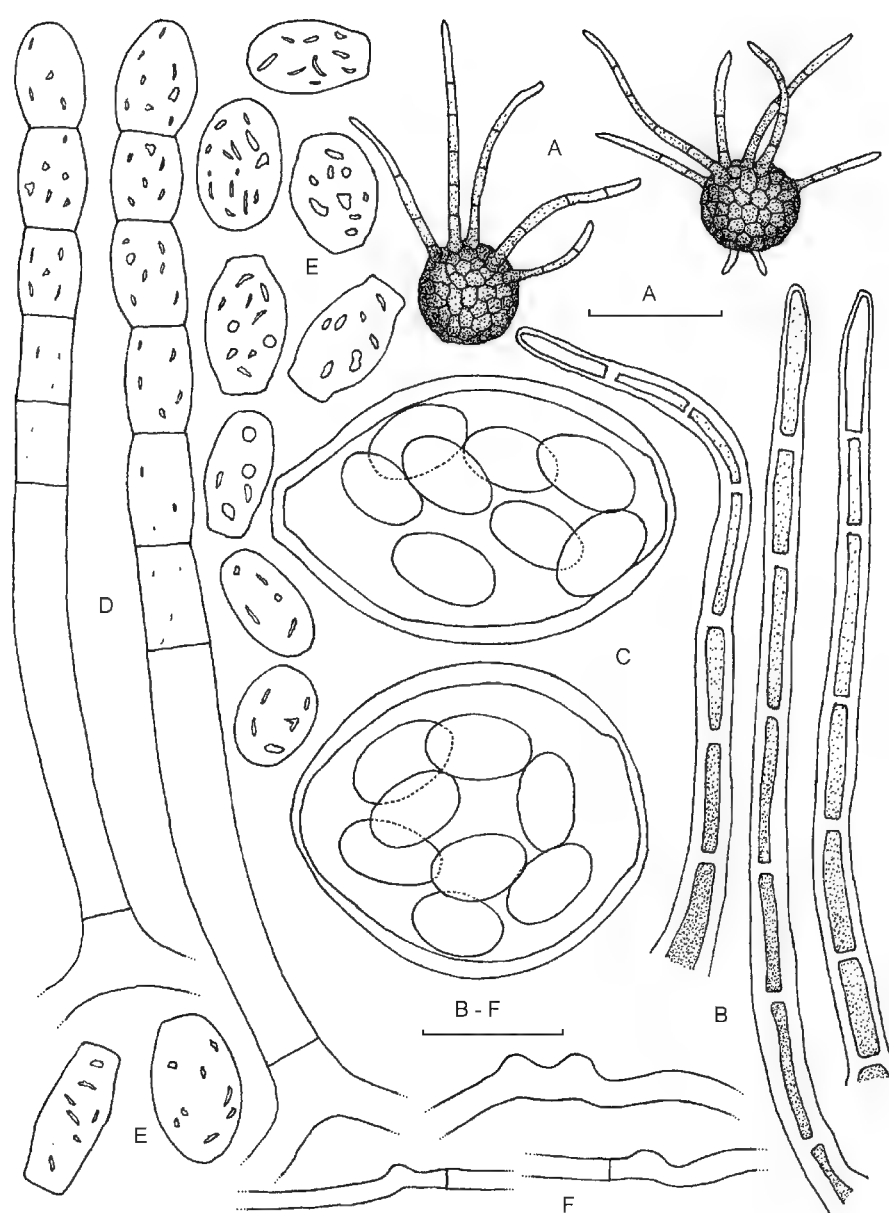


FIG. 1. *Podosphaera setacea* (holotype).

A. Chasmothecia, B. Appendages, C. Asci and ascospores,
D. Conidiophores, E. Conidia, F. Hyphae and appressoria.

Scale bar = 100 µm (A), 25 µm (B-F). T.Z. Liu del.

sect. *Podosphaera* characterized by having terminally arising appendages with usually unbranched apex. There are seven species of *Podosphaera* sect. *Sphaerotheca* on hosts of the *Rosaceae*, *Podosphaera aphanis* (Wallr.) U. Braun & S. Takam. [= *Sphaerotheca aphanis* (Wallr.) U. Braun], *P. ferruginea* (Schltdl.) U. Braun & S. Takam. [= *S. ferruginea* (Schltdl.) L. Junell], *P. niesslii* (Thüm.) U. Braun & S. Takam. [= *S. niesslii* Thüm.], *P. pannosa* (Wallr.) de Bary [= *S. pannosa* (Wallr.) Lév.], *P. spiraeae* (Sawada) U. Braun & S. Takam. [= *S. spiraeae* Sawada, incl. *S. filipendulae* Z.Y. Zhao], *P. stephanandrae* (Jacz.) U. Braun & S. Takam. [= *S. stephanandrae* Jacz.], and *P. volkartii* (S. Blumer)

U. Braun & S. Takam. [= *S. volkartii* S. Blumer] (Braun 1987, 1995; Chen et al. 1987, Nomura 1997, Shin 2000). Most of these species are quite different from *P. setacea*, forming mycelioid appendages arising from the lower half of the chasmothecia. *Podosphaera ferruginea* and *P. spiraeae* are morphologically somewhat closer to the present species since they are characterized by having non-mycelioid, more setiform appendages, arising from the upper half of the chasmothecia (at least partly), but the two species are easily distinguishable from *P. setacea* by having ascomata with numerous (5–25), much longer appendages (about 1–6 times as long as the chasmothecial diam.) with thinner walls. Furthermore, the appendages are not terminal as in *P. setacea*, and they are horizontally spread.

(2) *Erysiphe buhrii* U. Braun, Česká Mykol. 32(2): 80, 1978.

FIG. 2

= *Erysiphe pisi* var. *buhrii* (U. Braun) Ialongo, Mycotaxon 44(1): 255, 1992.

(belonging in *Erysiphe* sect. *Erysiphe*)

MYCELIA amphigenous, effuse or forming thin white patches, often occupying the whole leaf surface, persistent or subevanescent. HYPHAE 3.5–8 µm wide, hyaline, thin-walled, smooth or rarely verruculose. APPRESSORIA distinctly lobed, opposite or single. CONIDIOPHORES erect, 80–128 µm long, foot-cells cylindrical, straight or sometimes flexuous, 26–64 × 8–11 µm, followed by 1–2 shorter cells, rarely a single second cell of approximately the same length. CONIDIA formed singly, ellipsoid or cylindrical, rugose (dried!), 26–37 × 12–19 µm. CHASMOTHECIA scattered to gregarious, dark brown, depressed globose, 98–144 µm diam. PERIDIUM CELLS irregularly polygonal, 10–20(–26) µm diam. APPENDAGES 10–30, in the lower half of the chasmothecium, mycelium-like, mostly interlaced with the mycelium, simple or frequently 1–2(–3) times irregularly to subdichotomously branched, flexuous, sometimes tortuous to geniculate, 0.3–1(–2.5) times as long as the chasmothecial diam., 40–170(–274) µm long, 3–6.5(–10) µm wide, thin-walled, smooth to somewhat rough, 0–4(–6)-septate, hyaline, yellowish to pale brown in the basal half, paler towards the apex, terminal portion hyaline, occasionally brown throughout, appendages short. ASCI (3–)4–9(–10), oval, oblong-oval or irregularly shaped, short-stalked or sessile, 64–88 × 25–43 µm. ASCOSPORES (2–)3–5(–6) per ascus, ellipsoid or ovoid, yellowish, 19–26 × 11–18 µm.

SPECIMEN EXAMINED: CHINA. INNER MONGOLIA, Chifeng City, Hexigten Banner, Dalainur National Nature Reserve, Zhenzi Mountain, ca. 1350m alt., on living leaves of *Stellaria dichotoma* var. *lanceolata* Bunge (*Caryophyllaceae*), 5 Aug. 2008, T.Z. Liu & C. Sun, CFSZ 1309.

COMMENTS: Compared to the description of *Erysiphe buhrii* in Braun (1987, 1995), the foot-cells of the conidiophores in the present collection from China are somewhat shorter and wider, 26–64 × 8–11 µm [versus (35–)40–75(–100)

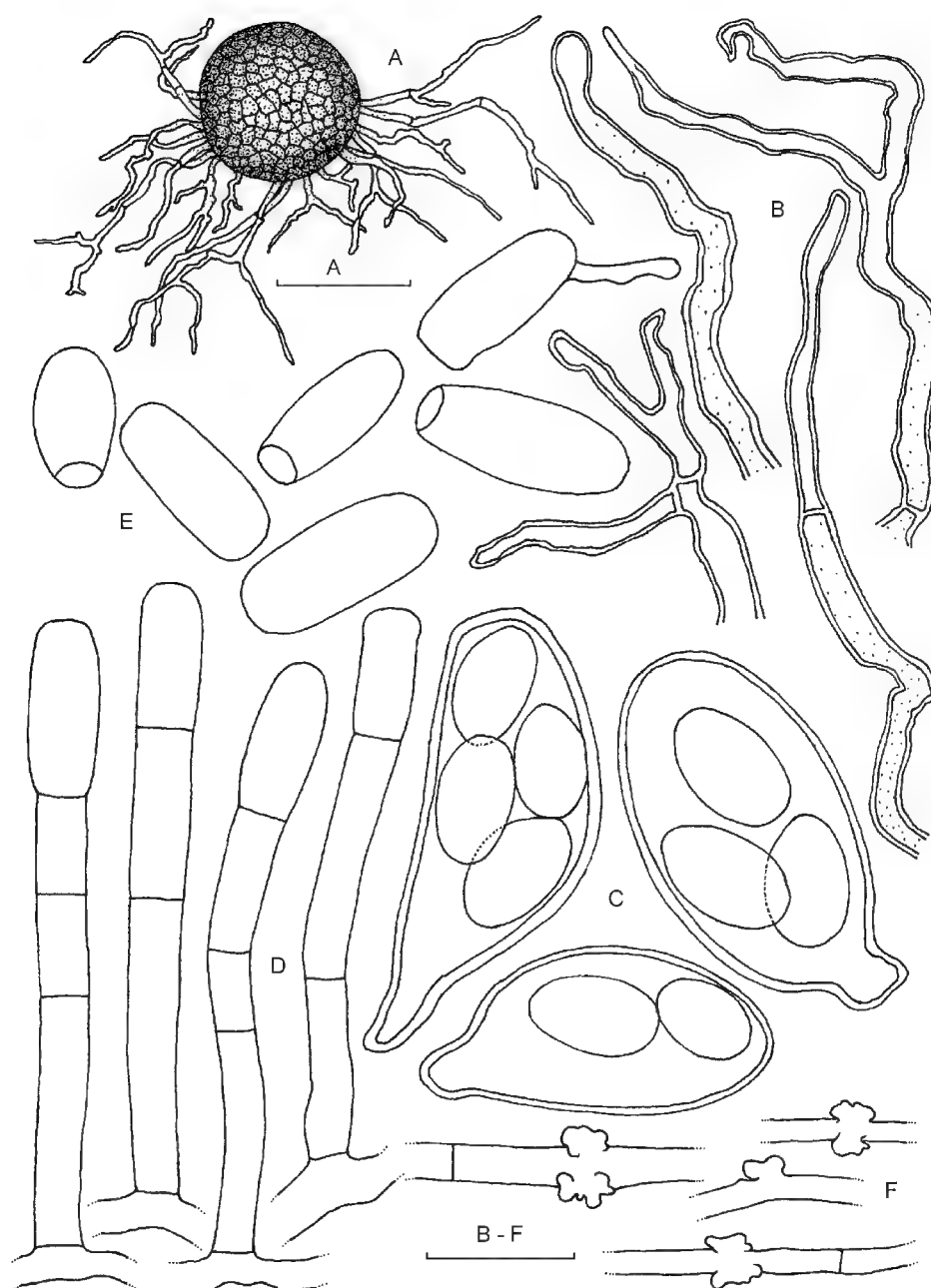


FIG. 2. *Erysiphe buhrii*.
 A. Chasmothecium, B. Appendages, C. Asci and ascospores,
 D. Conidiophore, E. Conidia, F. Hyphae and appressoria.
 Scale bar = 100 μm (A), 25 μm (B-F). T.Z. Liu del.

$\times 6.5\text{--}8.5(-10) \mu\text{m}$], and the conidia are somewhat smaller, $26\text{--}37 \times 12\text{--}19 \mu\text{m}$ [versus $30\text{--}50 \times 14\text{--}22.5 \mu\text{m}$]. However, the characters of the chasmothecia fully agree with those of *E. buhrii*. The differences in the dimensions of the anamorphs are regarded as modifications and variation within *E. buhrii*. This powdery mildew fungus is new to China, with *Stellaria dichotoma* var. *lanceolata* as new host plant for this fungus (Braun 1987, 1995; Amano 1986).

Acknowledgements

We are much obliged to U. Braun (Martin Luther University Halle, Germany) and Dean A. Glawe (Washington State University and the University of Washington) for their pre-submission reviews, to Shaun R. Pennycook for nomenclatural review. This study was supported by the Natural Science Foundation of the Inner Mongolia Autonomous Region of China (no. 20080404Zd11) and the Support Program for Young Disciplinary Leaders in Chifeng City (no. 200807).

Literature cited

- Amano K. 1986. Host range and geographical distribution of the powdery mildew fungi, 2nd ed. Tokyo, Japan Scientific Societies Press.
- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Nova Hedwigia, Beiheft 89: 1–700.
- Braun U. 1995. The powdery mildews (*Erysiphales*) of Europe. Gustav Fischer Verlag, Jena, Stuttgart, New York.
- Braun U, Takamatsu S. 2000. Phylogeny of *Erysiphe*, *Microsphaera*, *Uncinula* (*Erysipheae*) and *Cystotheca*, *Podosphaera*, *Sphaerotheca* (*Cystothecaceae*) inferred from rDNA ITS sequences – some taxonomic consequences. *Schlechtendalia* 4: 1–33.
- Braun U, Cook RTA, Inman AJ, Shin H-D. 2002. The taxonomy of the powdery mildew fungi. 13–54, in R Bélanger et al. (eds.): The powdery mildews: a comprehensive treatise. St. Paul, APS Press.
- Chen GQ, Han SJ, Lai YQ, Yu YN, Zheng RY, Zhao ZY. 1987. Flora fungorum sinicorum. Vol. 1 (*Erysiphales*). Beijing, Science Press. (in Chinese).
- Nomura Y. 1997. Taxonomical study of *Erysiphaceae* of Japan. Tokyo, Yokendo LTD. (in Japanese).
- Shin HD. 2000. *Erysiphaceae* of Korea. Suwon, National Institute of Agricultural Science and Technology.

***Spadicoides subsphaerica* sp. nov. from Connecticut**

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Abstract — *Spadicoides subsphaerica*, a new dematiaceous hyphomycete species is described and illustrated from a specimen collected from Hamden, CT.

Key Words — anamorphic fungi, saprobe, taxonomy

Introduction

The genus *Spadicoides* was erected by Hughes (1958), as typified by *S. bina* (Corda) S. Hughes [as ‘*binum*’] with six species accepted. The genus is characterized by distinct, single, unbranched, brown conidiophores with polytretic, integrated conidiogenous cells, solitary apical and lateral conidia, and minute pores visible on conidiogenous cells where conidia have developed and been released (Hughes 1958, Ellis 1971, Sinclair & Bhat 1985, Goh & Hyde 1996). Goh and Hyde (1996) reviewed the genus and accepted 21 species. Since the review, several additional species have been proposed: *Spadicoides arengae*, *S. bambusicola*, *S. hodgkissii*, *S. mauritiana*, *S. minuta*, *S. palmicola*, and *S. versiseptatis* (Cai et al. 2004, Dulymamode et al. 1999, Goh & Hyde 1999, Ho et al. 2002, Wong et al. 2002, Zhou et al. 1999).

A specimen collected from dead wood at the Lockwood Farm of The Connecticut Agricultural Experiment Station in Hamden, CT was found to be of an undescribed species of *Spadicoides*, which is described and illustrated in this paper.

Materials and methods

Conidiophores and conidia of the fungus were lifted with 2 × 3 mm transparent tape 600 (3M Co., St. Paul, MN) and mounted in lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid) or 85% lactic acid (Carmichael 1955). Microscopic observations were made using bright field and Nomarski differential interference contrast optics. Photomicrographs were taken with an

Olympus Microfire digital camera (Goleta, CA). Herbarium acronyms follow Index Herbariorum (Holmgren & Holmgren 1998).

Results

Spadicoides subsphaerica D.W. Li, anam. sp. nov.

FIGURES 1–8

MYCOBANK MB515400

Conidiophora macronemata, mononematica, solitaria, determinata, erecta, simplicia, non-ramosa, 39–77(105) µm longa, (2.5–)2.7–3.1(–3.2) µm lata, 3–7-septata, laevia, brunnea; cellulae conidiogenae polytreticae, terminales et intercalares, integratae, poris manifestis praeditae. Conidia unicellularia, solitaria, subsphaerica vel ellipsoidea, brunnea, laevia, (3.3–)3.8–4.6(–5.4) × (3.2–)3.5–4.1(–4.3) µm. Teleomorphosis ignota.

TYPE: UNITED STATES. CONNECTICUT, Hamden, Lockwood Farm, superficie in ligno. Coll. 5 viii 2009, BPI 879604 (holotype).

ETYMOLOGY: referring to the subglobose conidial shape.

Conidiophores differentiated, single, determinate, erect, unbranched, straight, dark brown, smooth, 3–7-septate, thick-walled, (38–)39–77(–105) (mean = 58 ± 19 , n = 20) × (2.5–)2.7–3.1(–3.2) µm (mean = 2.9 ± 0.2 , n = 20), more or less uniform in width, occasionally slightly enlarged at apex, upper half fertile and paler; apical cell (4.2–)6.4–9.0(–10) (mean = 7.7 ± 1.3 , n = 20) × (2.5–)2.8–3.2(–3.5) µm (mean = 3.0 ± 0.2 , n = 20). Conidiogenous cells integrated, terminal and intercalary, polytretic, leaving visible minute clear pores after conidial secession. Conidia apical and lateral, unicellular, single, subglobose, globose, or broadly ellipsoidal, brown to dark brown, smooth, thick-walled, with an occasionally visible, minutely protuberant clear pore at the base (3.3–)3.8–4.6(–5.4) (mean = 4.2 ± 0.4 , n = 30) × (3.2–)3.5–4.1(–4.3) (mean = 3.8 ± 0.3 , n = 30) µm, Q = 1–1.2(–1.5) (mean = 1.1 ± 0.1 , n = 30).

TELEOMORPH: unknown.

KNOWN GEOGRAPHICAL DISTRIBUTION: Connecticut, USA.

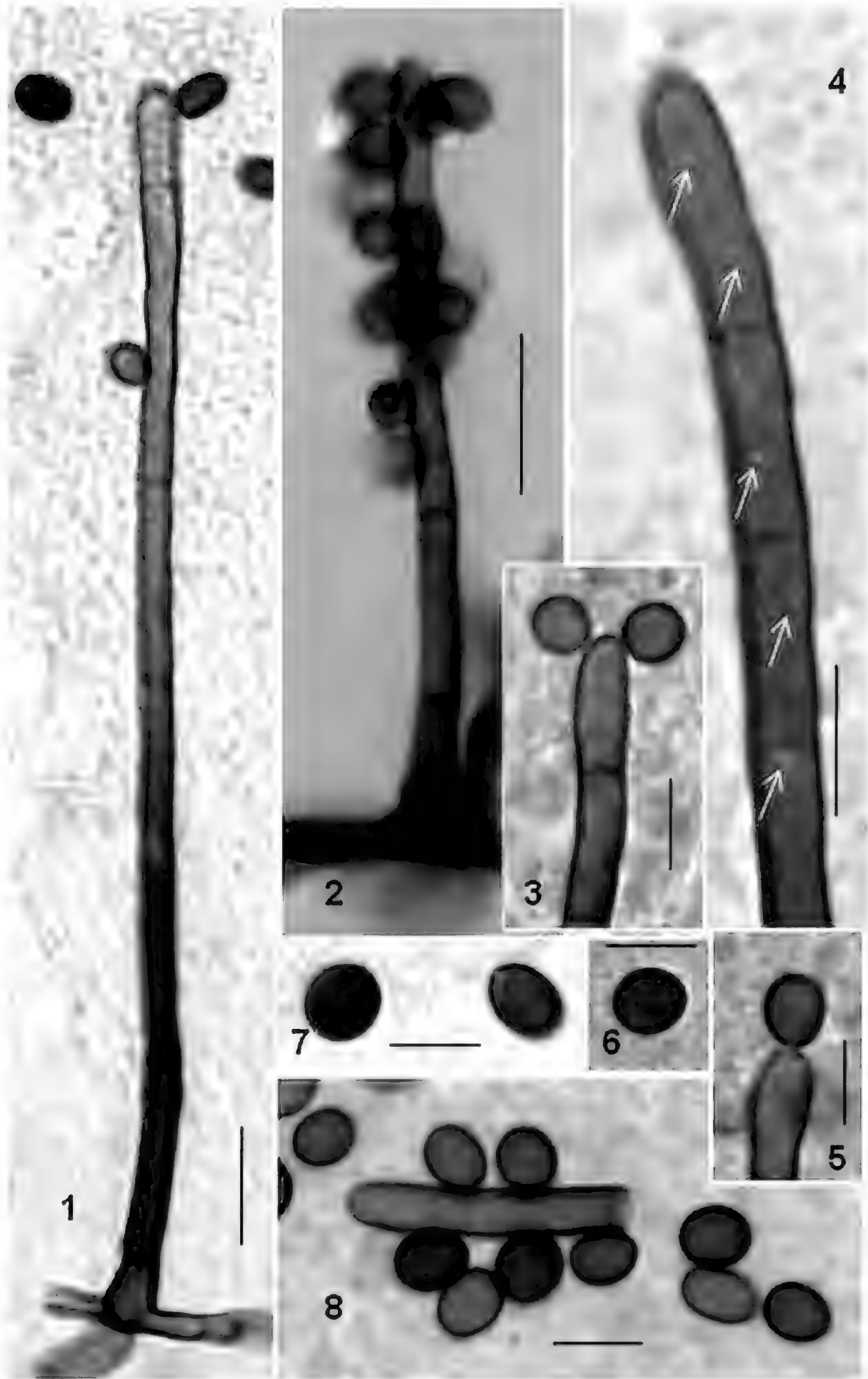
HABITAT: saprotrophic on dead wood of ?*Quercus* sp.

Discussion

Several *Spadicoides* species develop 1-celled conidia: *S. arengae* W.H. Ho et al. ex L. Cai et al., *S. atra* (Corda) S. Hughes, *S. cuneata* Kuthub. & Nawawi, *S. macrocontinua* Matsush., *S. minuta* L. Cai et al., *S. sphaerosperma* McKenzie,

FIGURES 1–8. *Spadicoides subsphaerica*. 1–2. Conidiophore and conidia. 3. Apical portion of a conidiophore with lateral conidia. 4. Conidiogenous pores shown by arrows. 5. Conidium at apex of a conidiophore. 6–7. Thick-walled conidia. 8. Conidia and apical portion of a conidiophore.

Scale bars: 1–2 = 10 µm, 3–8 = 5 µm.



and *S. verrucosa* V. Rao & de Hoog. *Spadicoides subsphaerica* is characterized by small conidia ($3.3\text{--}5.4 \times 3.2\text{--}4.3 \mu\text{m}$), which are brown to dark brown, subspherical or ellipsoidal, and smooth, one or more of which characters separate it from the other species. Species that develop much larger and differently shaped conidia include *S. arengae* ($11\text{--}18 \times 4\text{--}6 \mu\text{m}$, ellipsoid), *S. cuneata* ($9\text{--}12 \times 6\text{--}8 \mu\text{m}$, cuneiform), *S. macrocontinua* ($13.5\text{--}22 \times 7\text{--}9 \mu\text{m}$, obovoid), and *S. sphaerosperma* ($6\text{--}7 \mu\text{m}$, globose) (McKenzie 1982, Matsushima 1995, Goh & Hyde, 1996, Dulymamode et al. 1999, Ho et al. 2002). *Spadicoides atra*, *S. minuta*, and *S. verrucosa* develop conidia that overlap those of *S. subsphaerica* in size. However, *S. verrucosa* has verrucose, ellipsoidal conidia $4\text{--}5.5 \times 2\text{--}3 \mu\text{m}$ (Goh & Hyde 1996), and the conidia of *S. atra* are oblong, ellipsoidal to obovoid, and $4\text{--}6.5 \times 3\text{--}4 \mu\text{m}$ (Corda 1840, Matsushima 1975). *Spadicoides minuta* has subhyaline to hyaline, ellipsoidal to broadly ellipsoidal conidia with mucronate ends that measure $3\text{--}6 \times 2.5\text{--}3.5 \mu\text{m}$.

Acknowledgments

The author expresses his gratitude to Dr. Bryce Kendrick and Dr. Rafael F. Castañeda Ruiz for their critical review of the manuscript and suggestions for revision. The author is grateful to Dr. James A. LaMondia for his pre-submission review and Dr. Shaun Pennycook for his nomenclature review.

Literature cited

- Carmichael JW. 1955. Lacto-fuchsin: a new medium for mounting fungi. *Mycologia* 47: 611.
- Corda ACJ. 1840. *Icones Fungorum hucusque Cognitorum* 4: i–iii, 1–53, plates 1–10.
- Cai L, McKenzie EHC, Hyde KD. 2004. New species of *Cordana* and *Spadicoides* from decaying bamboo culms in China. *Sydowia* 56: 222–228.
- Dulymamode R, Kirk PM, Peerally A. 1999. Fungi from Mauritius: three new hyphomycete species on endemic plants. *Mycotaxon* 73: 313–323.
- Ellis MB. 1971. *Dematiaceous hyphomycetes*. Commonwealth Mycological Institute, Kew, Surrey, United Kingdom, 608 pp.
- Goh T-K, Hyde KD. 1996. *Spadicoides cordanoides* sp. nov., a new dematiaceous hyphomycete from submerged wood in Australia, with a taxonomic review of the genus. *Mycologia*, 88: 1022–1031.
- Goh T-K, Hyde KD. 1999 (“1998”). *Spadicoides palmicola* sp. nov. on *Licuala* sp. from Brunei, and a note on *Spadicoides heterocolorata* comb. nov. *Can. J. Bot.* 76: 1698–1702.
- Ho WH, Yanna, Hyde KD. 2002. Two new species of *Spadicoides* from Brunei and Hong Kong. *Mycologia* 94: 302–306.
- Holmgren PK, Holmgren NH. 1998. [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Hughes SJ. 1958. Revisiones Hyphomycetum aliquot cum appendice de nominibus rejiciendis. *Can. J. Bot.* 36: 727–836.
- Matsushima T. 1975. *Icones microfungorum a Matsushima lectorum*. Published by the author, Kobe, Japan. 209 pp. + 415 plates

- Matsushima T. 1995. Matsushima mycological memoirs no. 8. Published by the author, Kobe, Japan. 54 pp. + 120 plates.
- McKenzie EHC. 1982. New hyphomycetes on monocotyledons. New Zealand Journal of Botany 20: 245–252.
- Sinclair RC, Eicker A, Bhat DJ. 1985. Branching in *Spadicoides*. Trans. Brit. Mycol. Soc. 85: 736–738.
- Wong MKM., Goh TK, McKenzie EHC, Hyde KD. 2002. Fungi on grasses and sedges: *Paratetraploa exappendiculata* gen. et sp. nov., *Petrakia paracochinensis* sp. nov. and *Spadicoides versiseptatis* sp. nov. (dematiaceous hyphomycetes). Cryptogamie Mycologie 23: 195–203.
- Zhou DQ, Goh TK, Hyde KD, Vrijmoed LLP. 1999. A new species of *Spadicoides* and other hyphomycetes on bamboo from Hong Kong. Fungal Diversity 3: 179–185.

***Goplana dioscoreae-alatae* nom. nov. and other *Uredinales* on *Dioscoreaceae*: nomenclature and taxonomy ***

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Abstract — Among the sixteen species of rust fungi described on *Dioscoreaceae*, three require replacement names. This paper re-describes and proposes *Goplana dioscoreae-alatae* as a replacement name for *Goplana dioscoreae* Cummins, nom. illegit. We also propose *Uredo dioscoreae-doryphorae* as a replacement name for *Uredo spinulosa* Y. Ono, nom. illegit.; and *Aecidium tumbayensis* as a replacement name for *Aecidium dioscoreae* J.C. Lindq., nom. illegit. We discuss nomenclatural controversies surrounding these taxa.

Key words — *Dioscorea*, winged yam, invasive

Introduction

Winged yam (*Dioscorea alata* L.) originated in continental tropical Asia. It produces large, edible tubers, and is an important source of the steroid diogenin, used in birth control pills. *Dioscorea alata* was introduced into the Americas and is considered an invasive vine in Florida, where it can produce stems up to 30 ft. long.

One of the most economically significant rusts on *Dioscorea* is *Goplana dioscoreae* Cummins (winged yam rust). This rust has been reported from Asia and Pacific Islands (Ono 1982) and is considered to be of quarantine significance as a potentially invasive species for the United States. As such, it is listed by the USDA Animal and Plant Health Inspection Service (APHIS) as a Regulated Plant Pest (under the anamorph name *Uredo dioscoreae-alatae*) (Cline & Farr 2006).

* Research performed at USDA, Agricultural Research Service, Systematic Botany and Mycology Laboratory, Building 011A, 10300 Baltimore Avenue, Beltsville, MD 20705-2350, USA. Both authors contributed equally to the writing of this paper.

Goplana currently includes at least twelve species described on hosts of *Asteraceae*, *Dioscoreaceae*, *Euphorbiaceae*, *Grossulariaceae*, *Lauraceae*, *Magnoliaceae*, *Meliosmaceae*, *Rubiaceae*, and *Vitaceae* (Cummins & Hiratsuka 2003). The three species known to occur on *Dioscorea* are *G. dioscoreae* with aparaphysate uredinia and 6–9 obscure scattered germ pores per urediniospore, *G. australis* Y. Ono & J.F. Hennen with (4–)6–8(–9) equatorial germ pores per urediniospore (Ono 1982), and *G. ecuadorica* Syd. with paraphysate uredinia (Ono & Hennen 1983).

Worldwide, eighteen species of rust fungi are known on *Dioscoreaceae*, all on the host *Dioscorea* except *Uredo dioscoreicola* F. Kern, Cif. & Thurst. on *Rajania cordata* (Kern et al. 1933). Diagnostic characters of the fifteen other *Dioscorea*-associated species (representing six other genera) are outlined briefly below.

Aecidium dioscoreae J.C. Lindq. and *A. leonense* Cummins have an *Aecidium*-type anamorph with peridial cells (Lindquist 1953), differing from the *Uredo*-type anamorph of *G. dioscoreae*, which lacks peridial cells.

Cerotelium dioscoreae Berndt can be distinguished by urediniospores with two equatorial germ pores (Berndt 1997) (contrasting with the 6–9 obscure scattered germ pores found in *G. dioscoreae*).

Phakopsora dioscoreae Thaung has peripheral paraphysate uredinia (Ono 1982), while those of *G. dioscoreae* are aparaphysate.

Puccinia dioscoreae Kom., *P. valida* Arthur, and *P. dioscoreae-mundtii* Berndt et al. all produce one-septate teliospores and urediniospores with two (*P. dioscoreae* and *P. valida*) or 4–5 germ pores (*P. dioscoreae-mundtii*) (Berndt and Uhlmann 2006). *Goplana dioscoreae* has non-septate teliospores and 6–9 obscure, scattered germ pores per urediniospore.

Sphenospora pallida (G. Winter) Dietel has been reported on several *Dioscorea* species (Jørstad 1956). The urediniospores in the uredinial stage (*Uredo dioscoreae* Henn.) are larger (20–)22–26(–29) × 19–22 µm than those in *G. dioscoreae* (17–28 × 14–22 µm).

Seven species of *Uredo* have been reported on *Dioscorea*: *Uredo dioscoreae-aculeatae* Racib. has bilaterally ovate urediniospores that are spiny on the convex surface and smooth on the lower surface, *Hemileia*-like (Ono 1982), while those of *G. dioscoreae* are evenly echinulate. *Goplana dioscoreae* urediniospores are sub-globose to ellipsoid and relatively small, in contrast to urediniospores that are obovoid, ellipsoid, or pyriform and 28–38 × 20–26 µm in *U. dioscoreae-filiformis* Racib.; obovoid, ellipsoid, pyriform to oblong, often angular and (19–) 21–35 (–37) × 14–22 (–23) µm (Ono 1982) in *U. dioscoreae-sativae* Syd. & P. Syd.; and oblong, ellipsoid to obovoid and 32–45 × 14–28 µm (Jørstad 1956) in *U. pallatangae* Jørst. *Uredo dioscoreicola* has 3–4 equatorial germ pores per urediniospore (Kern et al. 1933) and *U. xenoporula* P. Syd. & Syd. (Sydow & Sydow 1924) a single germ pore at the base of the spore next to the pedicel

in contrast to the 6–9 obscure scattered germ pores found in *G. dioscoreae*. *Uredo spinulosa* Y. Ono has abundant uredinial paraphyses (Ono 1982), while uredinia of *G. dioscoreae* are aparaphysate.

At present, only eight rust taxa on *Dioscorea* are known to occur in the western hemisphere: *Aecidium dioscoreae* J.C. Lindq., *A. leonense*, *Cerotelium dioscoreae*, *Goplana ecuadorica*, *Puccinia valida*, *Sphenospora pallida*, *Uredo dioscoreicola*, and *U. pallatangae*. No rusts on *Dioscorea* have been reported from Europe, but a number of rust fungi have been reported from Africa, Asia, and Oceania.

Materials and methods

Specimens of *Uredo dioscoreae-alatae* housed at the U.S. National Fungus Collection and Herbarium of the Institute of Botany, Jagiellonian University, were examined. Material was mounted in aqueous lactic acid and examined using a Zeiss Axioplan 2 microscope with bright field optics. Size ranges were based on at least 20 measurements for each structure. Authorities of fungal names are based on recommendations given in Authors of Fungal Names (CABI): <http://www.indexfungorum.org/FungalNameAuthors.pdf>.

Results and discussion

Taxonomy and nomenclature of *Goplana dioscoreae-alatae*

***Goplana dioscoreae-alatae* J.R. Hern. & E.T. Cline, nom. nov.**

MYCOBANK 515307

= *Goplana dioscoreae* Cummins, Bull. Torrey Bot. Club 87: 35. 1960,
nom. illeg., non (Berk. & Broome) Cummins 1935.

ANAMORPH (UREDINIAL STATE):

***Uredo dioscoreae-alatae* Racib., Paras. Alg. Pilz. Java's 1: 29. 1900.**

= *Aecidium dioscoreae* Berk. & Broome, Journ. Linn. Soc. Bot. 14: 95. 1873,
non Lindq. 1953 [= *Aecidium tumbayensis* J.R. Hern. & E.T. Cline].

= *Uredo dioscoreae* (Berk. & Broome) Petch, Ann. Roy. Bot. Gard. Paraneidiya 5:
252. 1912, nom. illegit., non Henn. 1896 [anamorph of *Sphenospora pallida*].

= *Goplana dioscoreae* (Berk. & Broome) Cummins, Mycologia 27:
607. 1935 [anamorphic name in a teleomorphic genus].

= *Uredo dioscoreae-pyrifoliae* J.M. Yen, Rev. Mycol. (Paris) 34: 327. 1970.

Spermogonia and aecia unknown. Uredinia amphigenous, on petioles, caulicolous, deep-seated in host tissues, long covered by elevated, cupulate, thick, dark brown host tissue, erumpent by irregular central apertures, small, less than 1 mm diam., scattered or grouped in areas up to 5 mm diam., on dark leaf spots. Urediniospores pedicellate, sub-globose to ellipsoid, almost hyaline to pale yellow to pale chestnut-brown, 17–28 × 14–22 µm, wall echinulate, 2–3 µm thick; germ pores obscure, 6–9, scattered. Telia hypophyllous, minute, densely gregarious, subepidermal, erumpent, waxy and gelatinous when wet.

Teliospores in groups, on large, laterally free cells, cylindric, $(46-)50-77 \times 7-11 \mu\text{m}$, walls thin, colorless; metabasidia form by continuous apical elongation of probasidial cells.

TYPE: on *Dioscorea alata*, near Manila, Luzon, PHILIPPINES, 2 Dec. 1912, P.W. Graff (Sydow, Fungi Exotici Exsiccati n° 230, as *Uredo dioscoreae-alatae*), PUR-F1270, Holotype, BPI 154672!, Isotype of *Goplana dioscoreae-alatae*. [The specimen includes both anamorphic and teleomorphic states, although only the anamorph was originally described under the name *Uredo dioscoreae-alatae*.]

OTHER SPECIMEN EXAMINED: on *Dioscorea alata*, Buitenzorg, JAVA, 1898, M. Raciborski (KRA-F 1898-43(J))! II, Type of *Uredo dioscoreae-alatae* (as *Uredo dioscoreae* on specimen envelope).

HOSTS: *Dioscorea alata*, *D. bulbifera* L., *D. esculenta* (Lour.) Burkill, *D. pyrifolia* Kunth, *D. transversa* R. Br., and *Dioscorea* sp. (*Dioscoreaceae*).

GEOGRAPHIC DISTRIBUTION: Australia, Brunei, Indonesia, Java, Malaysia, New Caledonia, Pacific Islands, Papua New Guinea, Philippines, Singapore, Sri Lanka.

NOMENCLATURAL COMMENTS — Cummins (1935) was the first to describe the teleomorphic (telial) state of this fungus, when he published the new combination *Goplana dioscoreae* (Berk. & Broome) Cummins. Cummins (1935) did not provide a Latin description of the teleomorphic state and thus failed to fulfill the requirements for valid publication of a sp. nov. (McNeill et al., 2006, Art. 36.1). Although some authors (Cummins 1960, Ono 1982, Ono & Hennen 1983) have listed “*Goplana dioscoreae*” Cummins 1935 as an invalid teleomorph name, this name cannot be treated as a teleomorphic sp. nov. and must be accepted as an anamorphic comb. nov. based on the type of *Aecidium dioscoreae* Berk. & Broome (McNeill et al., 2006, Art. 59.6).

In 1960, Cummins republished the name *Goplana dioscoreae* Cummins, this time providing a Latin description of the teleomorphic state and a teleomorphic holotypification. *G. dioscoreae* Cummins 1960 is therefore a validly published name for the teleomorph. Nevertheless, it cannot serve as the accepted name for the teleomorph, because it is an illegitimate later homonym of the anamorphic name *Goplana dioscoreae* (Berk. & Broome) Cummins (McNeill et al. 2006: Art. 59.6 Ex. 7).

No other legitimate name exists for the teleomorph of *Uredo dioscoreae-alatae*. We propose *Goplana dioscoreae-alatae* as a replacement name for the illegitimate later homonym *Goplana dioscoreae*.

New names and nomenclatural clarifications for *Uredinales* on *Dioscoreaceae*

Aecidium tumbayensis J.R. Hern. & E.T. Cline, **anam. nom. nov.**

MYCOBANK 515308

≡ *Aecidium dioscoreae* J.C. Lindq., Rev. Fac. Agron. 29(1a):

41. 1953, nom. illeg., non Berk. & Broome 1875.

TYPE: on leaves of *Dioscorea* sp. from ARGENTINA, Jujuy, Dpto. Tumbaya. Abra Grande de Volcán, 2900–3200 m, 23 January 1953, Sleumer 3551 (LPS 22259) I, Holotype.

HOST: *Dioscorea* sp.

GEOGRAPHIC DISTRIBUTION: known only from the type specimen from Argentina.

Uredo dioscoreae-doryphorae* J.R. Hern. & E.T. Cline, *anam. nom. nov.

MYCOBANK 515309

≡ *Uredo spinulosa* Y. Ono, Trans. Br. Mycol. Soc. 79(3): 426. 1982,
nom. illeg., non (Cooke) Sacc. 1891, nec Dietel 1897.

“*Uredo dioscoreicola*” Sawada, Trans. Nat. Hist. Soc. Taiwan 33: 98. 1943,
nom. inval. [non *Uredo dioscoreicola* F. Kern et al. 1933].

HOLOTYPE: on *Dioscorea doryphora* Hance, Kusukusu, Takao, TAIWAN, Oct. 22, 1908,
R. Suzuki (TS-R500. Mycological Herbarium of the Institute of Agriculture and Forestry,
University of Tsukuba, Japan) (not seen).

HOSTS: *Dioscorea doryphora* (*Dioscoreaceae*).

GEOGRAPHIC DISTRIBUTION: Taiwan. Known only from the type locality.

NOMENCLATURAL COMMENTS — The initial description of this rust was by Sawada (1943), in Japanese, under the name *Uredo dioscoreicola*. Because Sawada did not provide a Latin description, the name was not validly published (McNeill et al. 2006, Art. 36.1). Ono (1982) proposed the name *Uredo spinulosa* to validate “*Uredo dioscoreicola*” Sawada. However, he inadvertently created an illegitimate later homonym of *Uredo spinulosa* (Cooke) Sacc. and *Uredo spinulosa* Dietel; thus no legitimate name currently exists for this rust, and we propose the replacement name *Uredo dioscoreae-doryphorae*.

***Uredo dioscoreicola* F. Kern, Cif. & Thurst., Ann. Mycol. 31: 24. 1933.**

HOLOTYPE: on *Dioscorea altissima* Lam., from DOMINICAN REPUBLIC, La Vega,
Cordillera Central, Bonao, at Río Maimón, 200 m, 17 Dec. 1930, R. Cifferi & E.L. Ekman
3936 (BPI 847174) II!.

HOSTS: *Dioscorea altissima*, *D. polygonoides* Humb. & Bonpl. ex Willd., *D. urophylla*
Hemsl., *Dioscorea* sp., and *Rajania cordata* L. (*Dioscoreaceae*).

GEOGRAPHIC DISTRIBUTION: Brazil, Cuba, Dominican Republic, Panama, Puerto Rico,
and Virgin Islands.

NOMENCLATURAL COMMENTS — Arthur (1924) described Puerto Rican and Cuban specimens of a rust on *Dioscorea* that he identified as *Uredo dioscoreae* Henn. 1896. Kern et al. (1933) recognized that these collections had been misidentified, and published *Uredo dioscoreicola*, as an avowed nom. nov. to replace “*Uredo dioscoreae* Arthur, . . . not *Uredo dioscoreae* P. Henn.” Stevenson (1975) continued to cite “*Uredo dioscoreae* Arth. . . . non P. Henn.” as a synonym of *Uredo dioscoreicola*. However, Arthur (1924) clearly attributed the name *Uredo dioscoreae* to Hennings; he did not explicitly exclude the type of Hennings’ name in his description, and therefore his use of the name *Uredo dioscoreae* must be interpreted as a broadening of Hennings’ original species concept to include the collections from Puerto Rico and Cuba. There is no validly published name

“*Uredo dioscoreae* Arthur”, and *Uredo dioscoreicola* must be treated as a sp. nov. (with no valid synonyms), and not as a nom. nov.

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We would like to acknowledge Amy Rossman and Meike Piepenbring for their careful reading of the manuscript, the curators of BPI and the Herbarium of the Institute of Botany, Jagiellonian University for kindly providing specimens for examination, and the reviewers Anibal Alves de Carvalho Jr. and Mauricio Salazar Yepes and editors Shaun Pennycook and Lorelei Norvell for their helpful comments.

Literature cited

- Arthur JC. 1924. *Aecidiaceae* [Concluded]. N. Amer. Fl. 7: 605–648.
- Berndt R. 1997. *Cerotelium dioscoreae*, a new rust fungus on *Dioscorea*. Mycol. Res. 101: 311–314.
- Berndt R, Uhlmann E. 2006. New species, reports, observations and taxonomical changes of southern African rust fungi (Uredinales). Mycol. Progress 5: 154–177.
- Cline ET, Farr DF. 2006. Synopsis of fungi listed as regulated plant pests by the USDA Animal and Plant Health Inspection Service: Notes on nomenclature, disease, plant hosts, and geographic distribution. Online. Plant Health Progress doi:10.1094/PHP-2006-0505-01-DG.
- Cummins G. 1935. Notes on some species of the *Uredinales*. Mycologia 27: 605–614.
- Cummins G. 1960. Descriptions of tropical rusts-IX. Bull. Torrey Bot. Club 87: 31–45.
- Cummins G, Hiratsuka Y. 2003. Illustrated Genera of Rust Fungi. Third edition. American Phytopathological Society, St. Paul, Minnesota. 225 p.
- Jørstad I. 1956. *Uredinales* from South America and tropical North America. Ark. Bot. 3: 443–490.
- Kern F, Ciferri R, Thurston Jr H. 1933. The rust-flora of the Dominican Republic. Ann. Mycol. 31: 1–40.
- Lindquist J. 1953. Notas Uredinologicas. Rev. Fac. Agron. Univ. Nac. La Plata 29(1a): 35–44.
- McNeill J, Barrie F, Burdet H, Demoulin V, Hawksworth D, Marhold K, Nicolson D, Prado J, Silva P, Skog J, Wiersema J, Turland N. 2006. International Code of Botanical Nomenclature (Vienna Code). Regnum Vegetabile 146. A.R.G. Gantner Verlag KG.
- Ono Y. 1982. Rusts of yams in Southeast Asia and South Pacific. Trans. Brit. Mycol. Soc. 79: 423–429.
- Ono Y, Hennen J. 1983. Taxonomy of the Chaconiaceae genera (*Uredinales*). Trans. Mycol. Soc. Japan 24: 369–402.
- Sawada K. 1943. Materials of the Formosan Fungi (52). Trans. Nat. Hist. Soc. Taiwan 33: 96–100.
- Stevenson J. 1975. Fungi of Puerto Rico and the American Virgin Islands. Contr. Reed Herb. 23. 743 p.
- Sydow P, Sydow H. 1924. Monographia Uredinearum. Vol. 4. Uredineae imperfectae. F. Borntraeger, Leipzig. 671 p.

Two new species of *Septobasidium* (Septobasidiaceae) from southern China

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Abstract — Two new species, *Septobasidium broussonetiae* on *Broussonetia papyrifera* associated with *Pseudaulacaspis* sp., and *Septobasidium meizhouense* on *Prunus mume* associated with *Pseudaulacaspis pentagona*, are described. They were collected from Guangxi Zhuang Autonomous Region and Guangdong Province respectively, southern China.

Key words — *Pucciniomycetes*, *Septobasidiales*, taxonomy

Previously, six species of *Septobasidium* have been recorded in Guangxi Zhuang Autonomous Region (Couch 1938, Tai 1979, Mo et al. 2008). They are: 1) *Septobasidium albidum* Pat. 1893, 2) *S. bogoriense* Pat. 1899, 3) *S. leucostemum* Pat. 1920, 4) *S. reinkingii* Couch ex L.D. Gómez & Henk 2004, 5) *S. sinense* Couch ex L.D. Gómez & Henk 2004 and 6) *S. tanakae* (Miyabe) Boedijn & B.A. Steinm. 1931. An additional new species on *Broussonetia papyrifera*, found from the region, is described as:

Septobasidium broussonetiae C.X. Lu, L. Guo & J.G. Wei, sp. nov. FIGS. 1, 3–8

MYCOBANK MB 515462

Basidiomata resupinata, 1.5–7 cm longa, 1–3 cm lata, griseo-brunnea vel brunnea, margine determinata, spongiosa, superficie laevia, maturitate fissurata, interdum

*corresponding author

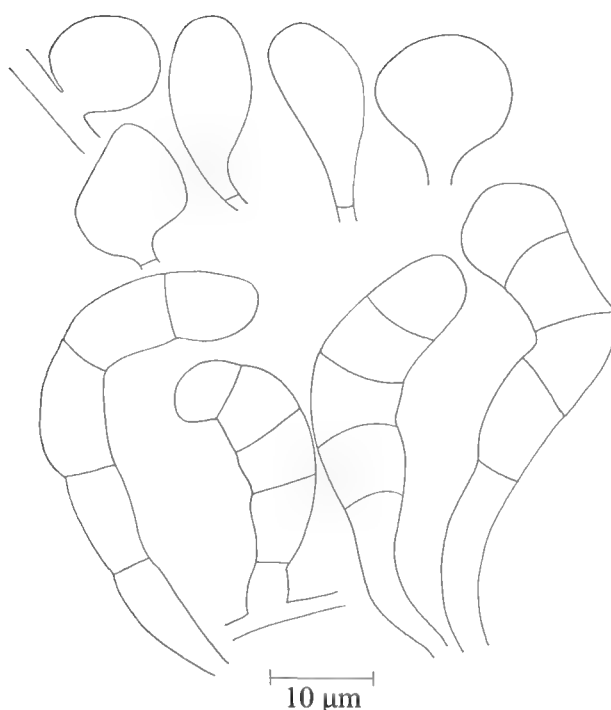


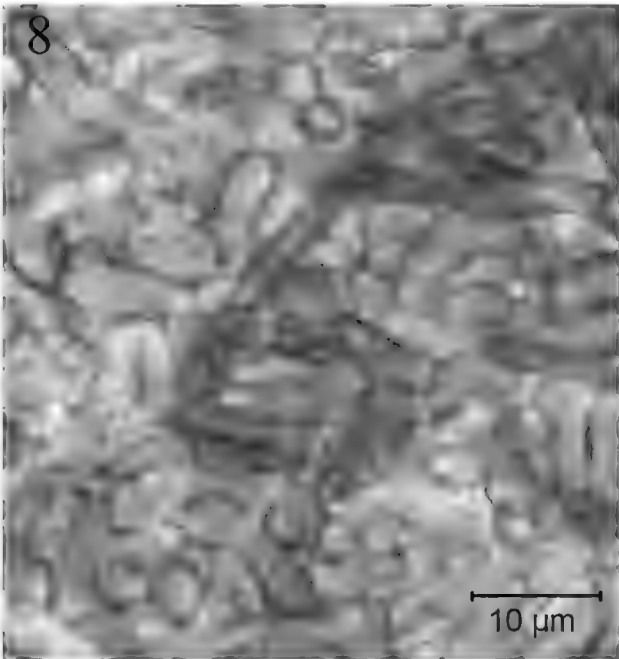
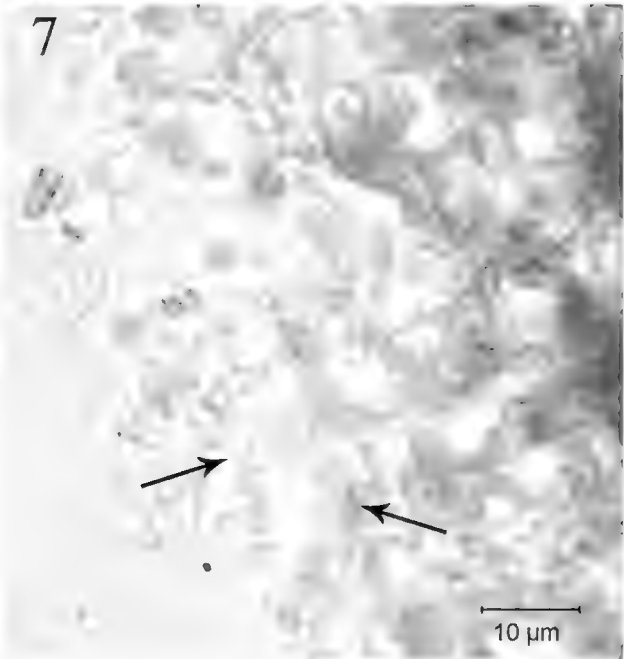
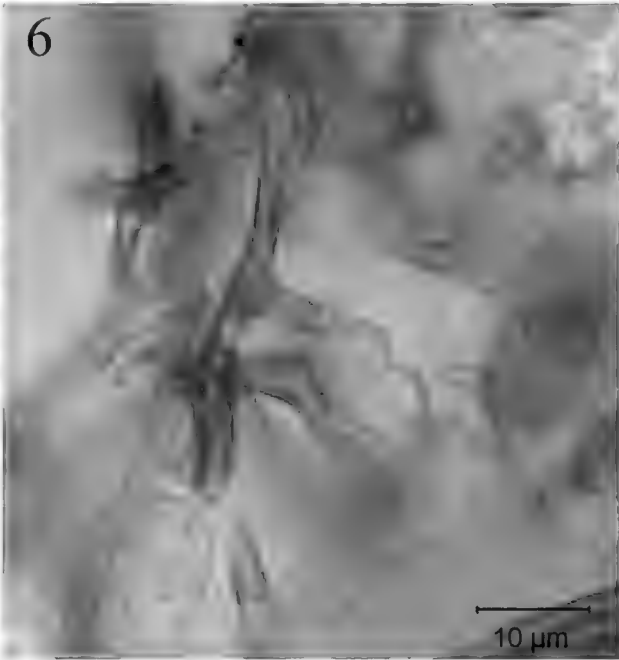
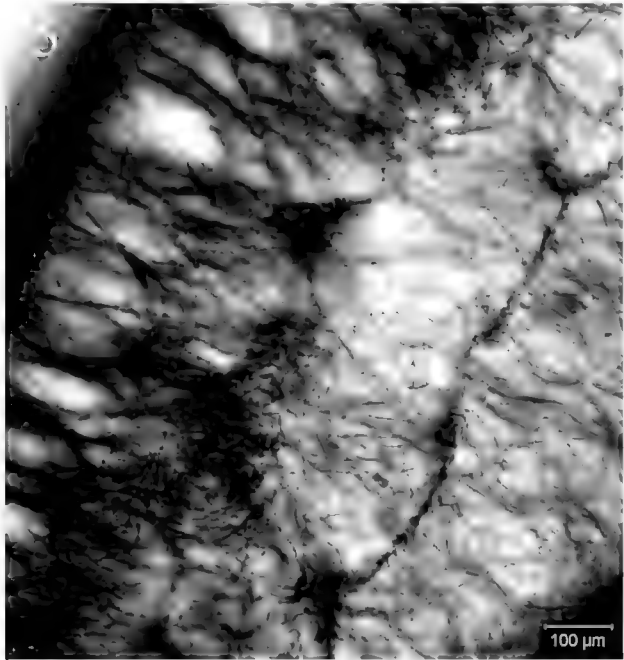
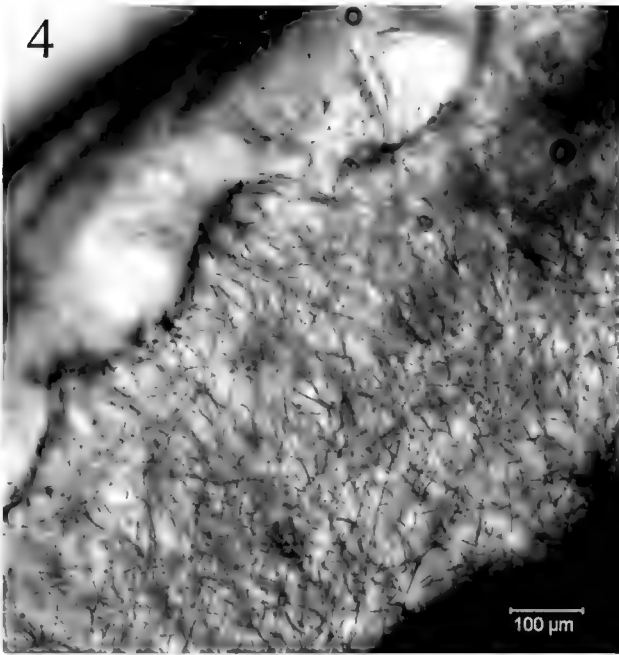
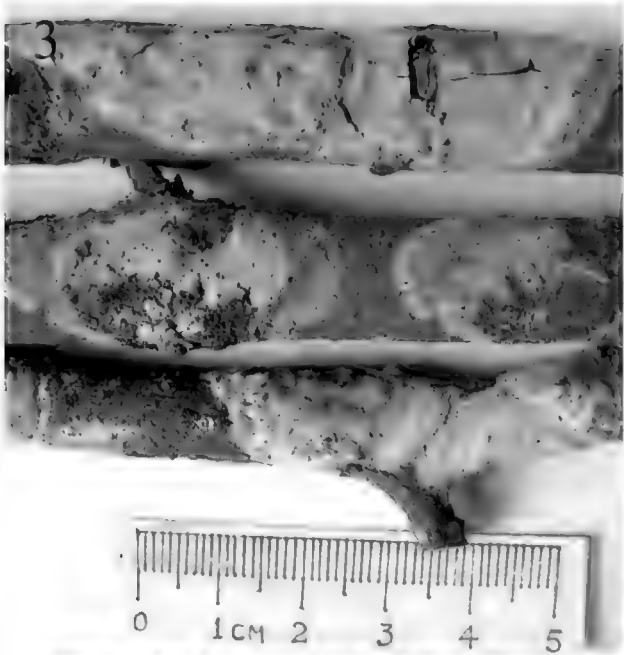
FIG. 1. Probasidia and basidia of *Septobasidium broussonetiae*.
(HMAS 197043, holotype)

spinulosa, in sectione 770–1150 μm crassa. Subiculum brunneum, 35–70 μm crassum. Contextus 2–3-stratosus, stratis horizontalibus primariis 360–640 μm altis, secundariis 180–300 μm altis, tertiis 35–360 μm altis, saepe columnas formantibus. Hymenium 30–110 μm crassum. Probasidia pyriformia, subglobosa vel ovoidea, 9–16 \times 7–12.5 μm , subhyalina vel brunneola, persistentia. Basidia cylindrica, curvata, 4-cellularia, 24–28 \times 6–7 μm , hyalina. Sterigmata conica, 2–3 μm longa. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Broussonetia papyrifera* Vent. (Moraceae): China, Guangxi, Nanning, Jiepai, 18.V.2009, J.G. Wei 2, HMAS 197043 (holotype), associated with *Pseudaulacaspis* sp. (Diaspididae).

Basidiomata on branches, resupinate, perennial, 1.5–7 cm long, 1–3 cm wide, greyish brown or brown; margin determinate, spongy; surface smooth at first, becoming broken by a few cracks at maturity, and sometimes spinulose near margin. In section 770–1150 μm thick. Subiculum brown, 35–70 μm thick. From the subiculum arise the fungal hyphae, occasionally form pillars, 360–640 μm high, branched outwards to form horizontal layer, from which the fungal hyphae renew growth to form the second layer, 180–300 μm high. The top layer is usually pillars, 35–360 μm high. Hymenium 30–110 μm thick. Probasidia pyriform, subglobose or ovoid, 9–16 \times 7–12.5 μm , subhyaline or brownish; probasidial cell persisting. Basidia cylindrical, curved, 4-celled, 24–28 \times 6–7 μm , hyaline. Sterigmata conical, 2–3 μm long. Basidiospores not seen. Haustoria consisting of irregularly coiled hyphae.

FIGS. 3–8. *Septobasidium broussonetiae* (HMAS 197043, holotype). 3. Basidiomata on branches. 4–5. Sections of basidiomata. 6. Probasidia. 7. Basidia (arrows). 8. Haustoria.



REMARKS: *Septobasidium broussonetiae* is similar to *S. reinkingii* but differs mainly in producing persistent probasidia. *S. reinkingii* lacks a probasidial cell.

The second new species of *Septobasidium* on *Prunus mume* was collected from Meizhou in Guangdong province. The host plant is the official city flower and seriously affected by the felt fungus. It was reported as one of the main diseases of plum (Li 2008). We describe the new species as:

***Septobasidium meizhouense* C.X. Lu, L. Guo & J.B. Li, sp. nov.**

FIGS. 2, 9–14

MYCOBANK MB 515465

Basidiomata resupinata, 4.5–16 cm longa, 1.5–3 cm lata, brunneo-grisea vel grisea, margine determinata, superficie primum laevia, deinde fissurata, in sectione 400–650 μm crassa. Subiculum brunneolum, 10–30 μm crassum. Contextus ex hyphis 220–440 μm longis laxè impletus vel interdum basi columnis 70–85 μm longis, 80–190 μm crassis praeditus. Hymenium 100–150 μm crassum. Sine probasidio. Basidia cylindrica, leviter curvata vel recta, 4-cellularia, 27–37 \times 6–8 μm , hyalina. Sterigmata conica, 2–3 μm longa. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Prunus mume* Siebold & Zucc. (*Rosaceae*): China, Guangdong, Meizhou, 23.V.2009, J.B. Li 1, HMAS 197041 (**holotype**), associated with *Pseudaulacaspis pentagona* (*Diaspididae*).

Basidiomata on branches, resupinate, 4.5–16 cm long, 1.5–3 cm wide, brownish grey or grey; margin determinate; surface smooth, cracked by fissures. In section 400–650 μm thick. Subiculum pale brown, 10–30 μm thick. From subiculum

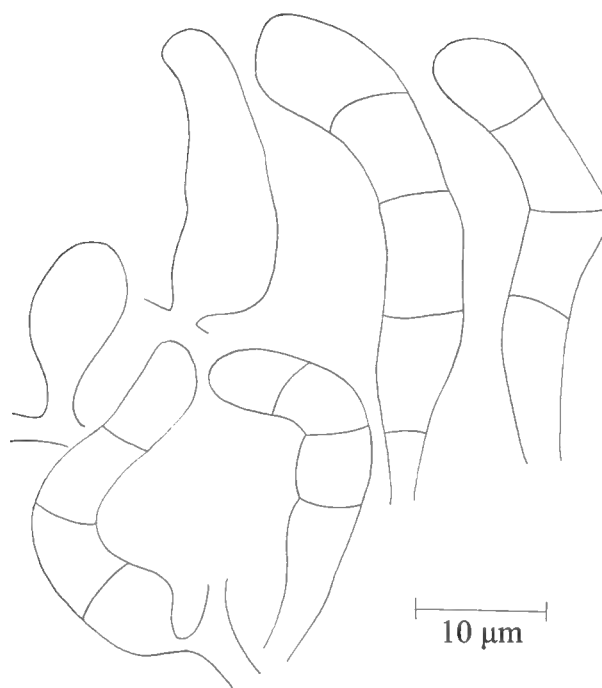
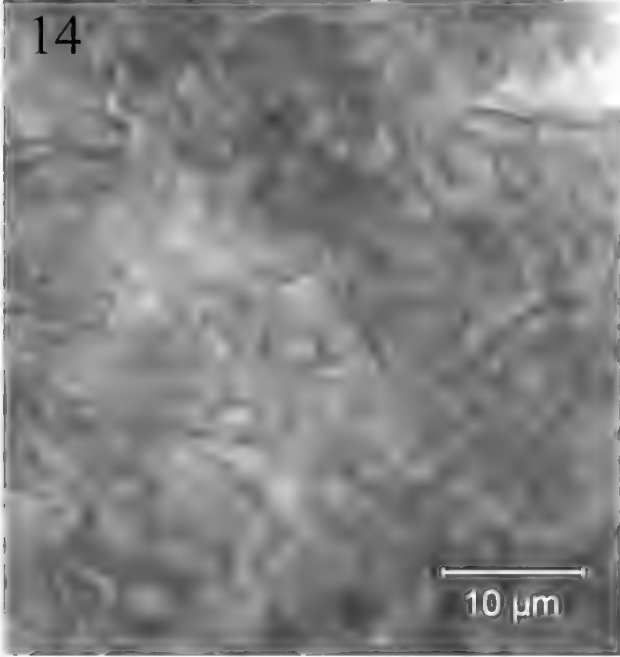
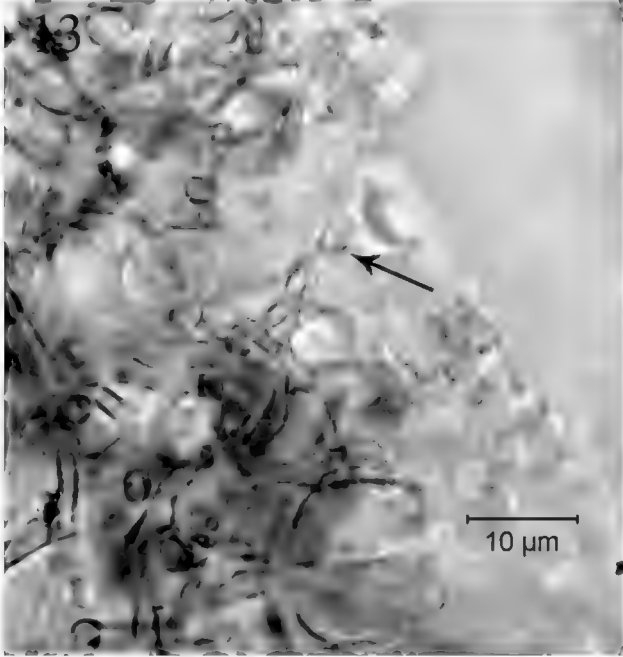
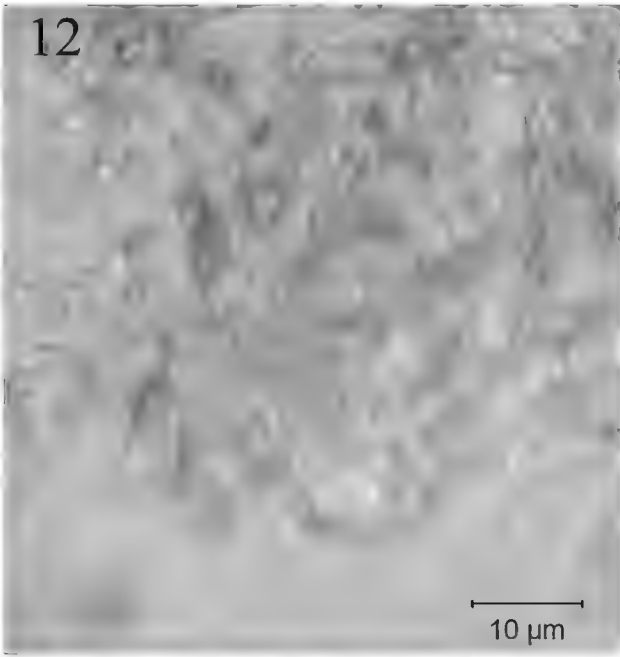
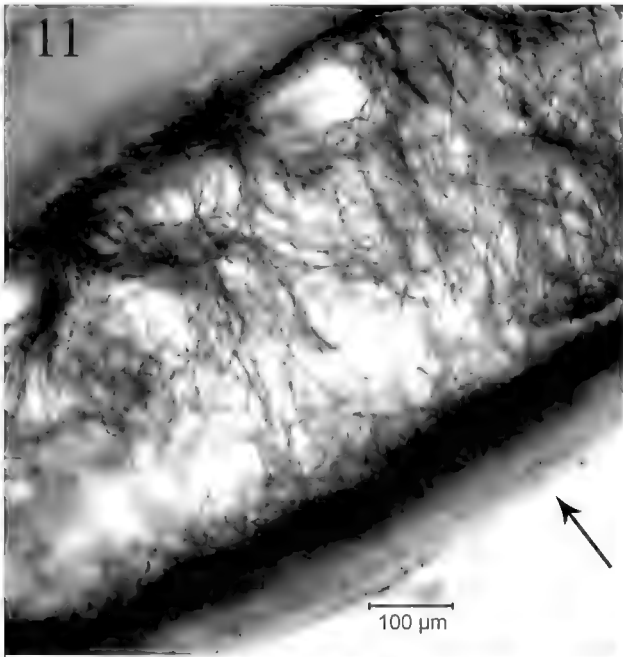
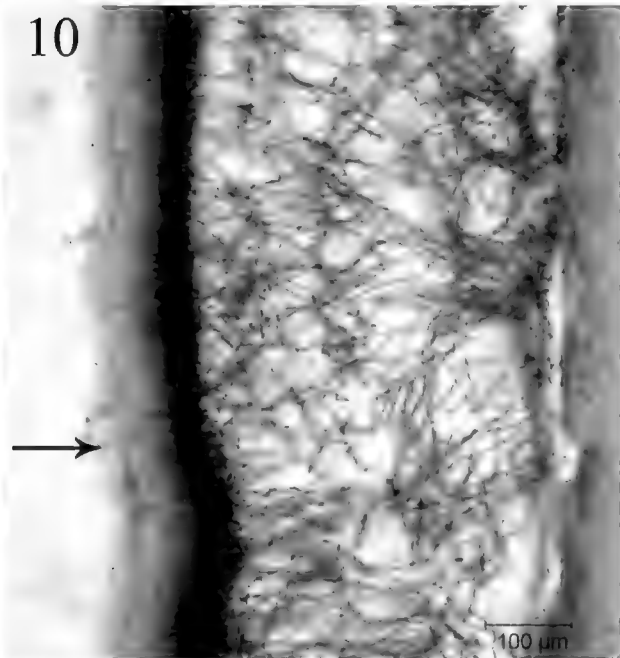


FIG. 2. Basidia of *Septobasidium meizhouense*.
(HMAS 197041, holotype)

FIGS. 9–14. *Septobasidium meizhouense* (HMAS 197041, holotype). 9. Basidiomata on branches. 10–11. Sections of basidiomata (hymenia, arrows). 12–13. Basidia (arrow). 14. Haustoria.



loosely filled with 220–440 µm long hyphae or at the base with 70–85 µm long and 80–190 µm wide pillars. Hymenial layer 100–150 µm thick, hyaline at the top. Basidia arising directly from the hyphae without a probasidial cell; cylindrical, slightly curved or straight, 4-celled, $27\text{--}37 \times 6\text{--}8$ µm, hyaline. Sterigmata conical, 2–3 µm long. Haustoria consisting of irregularly coiled hyphae. Basidiospores not seen.

REMARKS: *Septobasidium meizhouense* is similar to *S. pruni* C.X. Lu & L. Guo 2009, but the basidiomata differ in colour and thickness. Those of *S. meizhouense* are brownish grey or grey and 400–650 µm thick, while those of *S. pruni* are smoke brown or pale cinnamon brown and 170–330 µm thick.

To date, 21 species of *Septobasidium* have been reported in China (Sawada 1931, 1933, Couch 1938, Teng 1963, Tai 1979, Kirschner & Chen 2007, Lu & Guo 2009a,b,c) including the two new species in this paper.

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Literature cited

- Couch JN. 1938. The Genus *Septobasidium*. Univ. of North Carolina Press, Chapel Hill. 480 p.
- Kirschner R, Chen CJ. 2007. New reports of two hypophyllous *Septobasidium* species from Taiwan. *Fung. Sci.* 22(1,2): 39–46.
- Li JB. 2008. Research on relationship between *Septobasidium tanakae* and environment of plum. *Modern Landscape Architecture* 10: 19–21.
- Lu CX, Guo L. 2009a. *Septobasidium maesae* sp. nov. (*Septobasidiaceae*) from China. *Mycotaxon* 109: 103–106.
- Lu CX, Guo L. 2009b. Two new species of *Septobasidium* (*Septobasidiaceae*) from China. *Mycotaxon* 109: 477–482.
- Lu CX, Guo L. 2009c. *Septobasidium annulatum* sp. nov. (*Septobasidiaceae*) and *Septobasidium kameii* new to China. *Mycotaxon* 110: 239–245.
- Mo BP, Wei JG, Cao CM, Xian ZH, Huang X, Pan BN. 2008. Calendar of controlling diseases and pests of *Castanea mollissima*. *Edible Fung. China*. 27 (suppl.): 27–30.
- Sawada K. 1931. Descriptive catalogue of the Formosan fungi. Part V. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 51: 1–131.
- Sawada K. 1933. Descriptive catalogue of the Formosan fungi. Part VI. Rep. Dept. Agric. Govt. Res. Inst. Formosa. 61: 1–99.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Science Press, Beijing. 1527 p.
- Teng SC. 1963. *Fungi of China*. Science Press, Beijing. 808 p.

Dictyostelids from Ukraine 1: two new records of *Dictyostelium*

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Abstract —Two new records of *Dictyostelium* were isolated from leaf litter, and forest soil collected from Yalta, Crimea, Ukraine. Their descriptions and photographs of important life cycle stages are provided.

Key words —cellular slime mold, taxonomy

Introduction

Cellular slime molds, or dictyostelids, live primarily in field and forest soil and leaf litter and on animal dung where they feed selectively on bacteria (Singh 1947, Cavender & Raper 1965a,b). They are important agents in forest ecosystems by bringing changing soil bacterial flora. They are also ideal for investigating problems in cellular and developmental biology. *Dictyostelium*, *Polysphondylium*, and *Coenonia* (*Dictyosteliaceae*) and *Acytostelium* (*Acytosteliaceae*) are taxonomically placed in the order *Dictyosteliales* (Kirk et al. 2008). *Dictyostelium* is the oldest and largest dictyostelid genus and the first described species, *D. mucoroides* Bref., was first isolated and described from horse dung by Oskar Brefeld in 1869 (Raper 1984). Worldwide, approximately 60 *Dictyostelium* species have been described (Kirk et al. 2008). This paper is the first to report on dictyostelid in Ukraine.

Materials and methods

The authors collected 60 soil, grass, and leaf litter samples on October 8 and 10, 2008, in Baydar Valley, Eski-Kermen and Angara Valley, Yalta, Crimea, Ukraine. The samples were kept at 4 °C and isolated according to He & Li (2008). Five agar plates per sample were isolated and incubated at 23 °C with 12 h light

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and 12 h darkness. The location of each early aggregate clone and sorocarps was marked. The life cycle stages of cell aggregation, pseudoplasmodium, and sorocarp were observed under a Nikon dissecting microscope (SMZ1500) with 0.75–11.25× range (10× oculars). Spores, stalks, and sorocarps were measured using a Nikon light microscope (SMZ1000) with 10× oculars and 10, 40, and 100× (oil) objectives. Photographs were taken with a CANON S70 camera.

Taxonomy

1. *Dictyostelium implicatum* H. Hagiw., Bull. Natn. Sci. Mus., Tokyo, Ser. B, 10(2): 63 (1984).

FIG. 1 A–H

Sorocarps solitary, usually unbranched or sometimes irregularly branched, phototropic, sometimes tangled, usually prostrate. Sorophores colorless, sinuous, thin, 0.5–4.5(–10) mm long, tapering from bases to tips, bases conical sometimes expanded by basal disks, tips acuminate. Sori white, globose, 80–290 µm diam. Spores hyaline, elliptical, usually $6.6\text{--}8.8 \times 3.7\text{--}5.0$ µm, without polar granules. Cell aggregations radiate. Pseudoplasmodia not migrating without sorophore formation, usually producing single sorogens.

SPECIMENS EXAMINED: MR039. Isolated in 2009 from leaf litter collected by the authors in Baydar Valley (8 Oct. 2008, S0120) and Angara Valley (10 Oct. 2008, S0164), Yalta, Crimea, Ukraine. Deposited at the Herbarium of Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

COMMENTS—*Dictyostelium implicatum* strongly resembles *D. brefeldianum* H. Hagiw. (Hagiwara 1984) in growth habit, sorocarp dimensions, pattern of cell aggregation, and the shape of sorophore bases. But *D. implicatum* is distinguished from *D. brefeldianum* by three characteristics. Firstly, some sorocarps become tangled when its spores are inoculated in the center of a bacterial colony on the agar plate in diffuse light. Secondly, *D. implicatum* sorophore tips are acuminate, but *D. brefeldianum* has capitate sorophore tips. Thirdly, *D. implicatum* spores are elliptical and larger than the oblong spores of *D. brefeldianum* ($5.4\text{--}7.5 \times 3.0\text{--}4.2$ µm).

2. *Dictyostelium tenue* Cavender, Raper & Norberg, Amer. J. Bot. 66(2): 213 (1979).

FIG. 1 I–O

Sorocarps typically clustered, erect or semi-erect, phototropic, unbranched or branched near the base. Sorophores slender and delicate, colorless, consisting of one tier of cells except for bases, 1–6 mm long, bases slightly bulbous, tips capitate, sometimes prostrate. Sori milk-white, globose, mostly 45–125 µm diam. Spores hyaline, short, elliptical, usually $4.8\text{--}7.0 \times 2.5\text{--}3.8$ µm, with polar granules. Cell aggregations develop as streamless mounds. Microcysts produced in some strains, macrocysts not reported or observed.

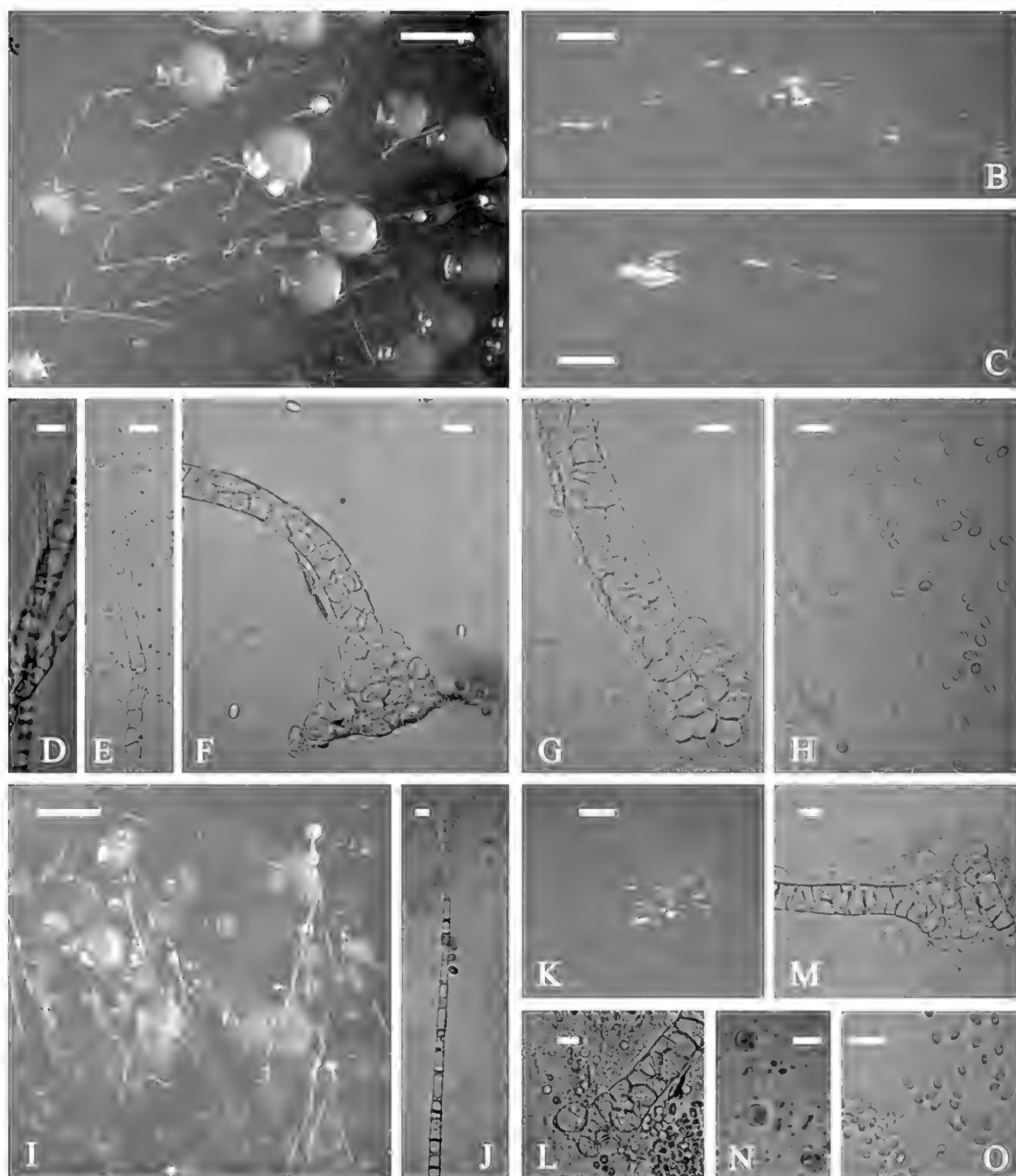


FIGURE 1. A–H, *Dictyostelium implicatum*; I–O, *D. tenue*. A, I, Sorocarps (bar = 1 mm); B, K, Cell aggregations (bar = 0.3 mm); C, Pseudoplasmodia (bar = 0.3 mm); D, E, J, Sorophore tips (bar = 15 μ m); F, G, L, M, Sorophore bases (bar = 15 μ m); H, O, Spores (bar = 15 μ m); N, Microcysts (bar = 5 μ m).

SPECIMENS EXAMINED: MR040. Isolated in 2009 from forest soil collected by the authors in Baydar Valley (8 Oct. 2008, S0127), Yalta, Crimea, Ukraine. Deposited at the Herbarium of Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

COMMENTS—This species resembles *D. multistipes* Cavender (Cavender 1976) in growth habit, cell aggregation, sorocarps, and irregularly branching

near the base. However, *D. tenue* has longer, more slender sorocarps than *D. multistipes* and show no yellow pigmentation. In addition, *D. tenue* resembles *D. monochasioides* H. Hagiw. (Hagiwara 1973), which differs in having a typically unbranched sorophore.

Acknowledgments

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Literature cited

- Cavender JC. 1976. Cellular slime molds of Southeast Asia. I. Description of new species. *Amer. J. Bot.* 63: 60-70.
- Cavender JC, Raper KB. 1965a. The *Acrasieae* in nature. II. Forest soil as a primary habitat. *Amer. J. Bot.* 52: 297-302.
- Cavender JC, Raper KB. 1965b. The *Acrasieae* in nature. III. Occurrence and distribution in forests of eastern North America. *Amer. J. Bot.* 52: 302-308.
- Hagiwara H. 1973. Enumeration of the *Dictyosteliaceae* (Mycological Reports from New Guinea and the Solomon Island. No. 17). *Bull. Natn. Sci. Mus., Tokyo, Ser. B.* 16: 493-496.
- Hagiwara H. 1984. Review of *Dictyostelium mucoroides* Brefeld and *D. sphaerocephalum* (Oud.) Sacc. et March. *Bull. Natn. Sci. Mus., Tokyo, Ser. B.* 10(1): 27-41.
- He XL, Li Y. 2008. A new species of *Dictyostelium*. *Mycotaxon* 106: 379-383.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi, 10th edition. Trowbridge, Cromwell Press.
- Raper KB. 1984. The Dictyostelids. Princeton University Press.
- Singh BN. 1947. Studies on soil *Acrasieae*. 1. Distribution of species of *Dictyostelium* in soils of Great Britain and the effects of bacteria on their development. *J. Gen. Microbiol.* 28: 417-429.

Checklist of the larger basidiomycetes in Bulgaria

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Abstract — A comprehensive checklist of the species of larger basidiomycetes in Bulgaria does not exist. The checklist provided here is the first attempt to fill that gap. It provides a compilation of the available data on the larger basidiomycetes reported from, or known to occur in Bulgaria. An alphabetical list of accepted names of fungi, recognized as occurring in Bulgaria is given. For each taxon, the distribution in Bulgaria is presented. Unpublished records about the distribution of some species are also added. An index of synonyms based on literature records from Bulgaria is appended. A list of excluded records, with reasons for their exclusion, is also given. The complete checklist is available at: <http://www.mycotaxon.com/>.

Key words — biodiversity, Bulgarian mycota, fungal diversity, macrofungi, taxonomy

Introduction

Bulgaria is situated in the Balkan Peninsula in southeastern Europe between 41°14' and 44°13' N, 22°20' and 28°36' E, covering an area of approximately 111 000 km². The country's landscape is very diverse. The most prominent mountain range is Stara Planina, running east to west and dividing the country into North and South Bulgaria. The highest part of the Macedonian-Rhodopean massif lies within Bulgarian territory, with its most impressive Rila-Rhodopean massif and its mountains Rila, Pirin, and Rhodopes. The highest peak in Bulgaria (and the entire Balkan Peninsula) is Mousala in Rila Mts, standing at 2925 m. Bulgaria has a temperate continental climate with a Mediterranean influence in its southernmost and easternmost areas.

The main types of natural vegetation present are nemoral, steppe, boreal-mountain, Arctic-Alpine, Mediterranean, and aquatic. The present-day plant cover is dominated by forested communities (32 % of the country area). The most common are the deciduous forests of *Quercus cerris*, *Q. frainetto*, *Q. pubescens*, *Q. dalechampii*, *Carpinus betulus*, *Fagus sylvatica*, etc. (nemoral

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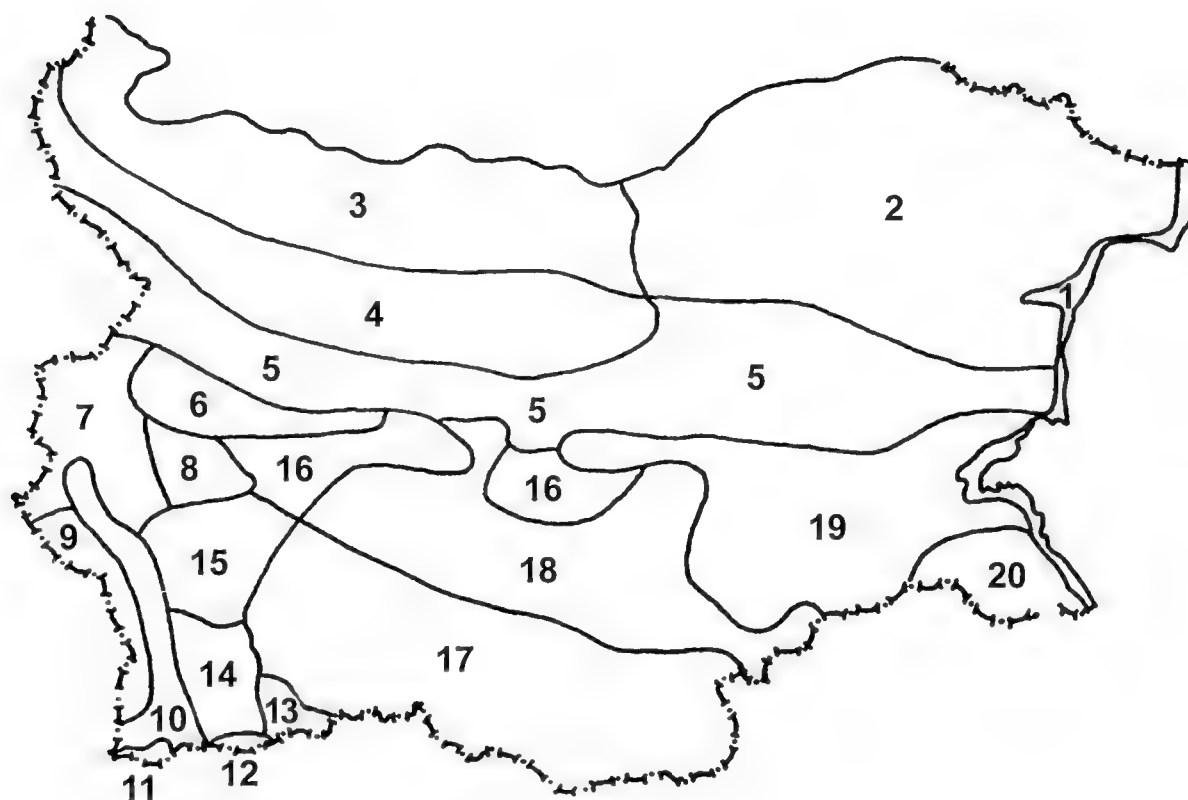


FIG. 1. Floristic regions of Bulgaria: [1] Black Sea coast, [2] Northeast Bulgaria, [3] Danubian Plain, [4] Forebalkan, [5] Stara Planina Mts (= Balkan Range), [6] Sofia region, [7] Znepole region, [8] Vitosha region, [9] West Frontier Mts, [10] Valley of River Strouma, [11] Mt Belasitsa, [12] Mt Slavyanka, [13] Valley of River Mesta, [14] Pirin Mts, [15] Rila Mts, [16] Mt Sredna Gora, [17] the Rhodopes, [18] Thracian Lowland, [19] Toundzha Hilly Country, and [20] Mt Strandzha.

vegetation), followed by the coniferous forests of *Pinus sylvestris*, *Pinus nigra*, *Picea abies*, *Abies alba*, *Pinus peuce*, etc. (boreal-mountain vegetation). In the lowlands, where the climate is drier, steppe grass vegetation is present, while above the tree line on the mountain ridges scrub (formations of *Pinus mugo* and *Juniperus sibirica*) and grass communities prevail (Arctic-Alpine vegetation). Mediterranean vegetation is comparatively rare and occurs only in the southernmost parts of the country, the Black Sea coast and in some midland Mediterranean spots. Typical examples of Mediterranean vegetation are communities of *Platanus orientalis*, *Quercus coccifera*, *Juniperus excelsa*, *J. oxycedrus*, *Phillyrea latifolia*, *Pistacia terebinthus*, *Paliurus spina-christi*, etc.

There is a substantial diversity in the Bulgarian flora, dictated by the varied landscape and the former glaciation processes in this part of the world, and more than 3900 plant species are found in the country (Petrova 2001).

Contemporary knowledge of Bulgarian larger basidiomycetes is based on a period of 104 years of investigations. The first contribution to the macrofungi from Bulgaria was published by Prof. S. Georgiev (1906). Assyov & Denchev (2004) published the first complete literature-based checklist of Bulgarian

Boletales and their synonyms. A comprehensive checklist of all species of larger basidiomycetes for the country does not exist. The checklist presented here is the first attempt in that direction. It provides a compilation of the available data on the larger basidiomycetes reported from, or known to occur in, Bulgaria. A selected list of literature sources that contain Bulgarian records of larger basidiomycetes is given at the end of the Internet version. The rest of the sources may be consulted in Denchev & Bakalova (2002), Fakirova et al. (2002), Assyov & Denchev (2004), Denchev & Petrova (2005), and Denchev et al. (2006, 2007).

The aim of this checklist is to summarize and present the correct names of the species currently known from Bulgaria, as well as to list their synonymous names occurring in the available sources on the fungi of Bulgaria. We hope that this paper will be a guide for future studies and a helpful source for creation of a database of the Bulgarian mycota.

We intend to regularly update the Internet version of this checklist.

Methods

The checklist is based on the literature data. All available Bulgarian sources were consulted, as well as some sources by European authors (Czech, etc.). A primary list of larger basidiomycetes has been developed. The taxa are given in alphabetical order. The numbers within square brackets, following the authors of each species or infraspecific taxon, refer to the floristic regions where the taxon is reported (FIG. 1). For three regions, a division into subregions is applied as follows: Stara Planina Mts (western, central, eastern), Mt Sredna Gora (western, eastern), and the Rhodopes (western, central, eastern). The generic and species treatment follows many of the recent monographs and particular articles on the European fungi. The names of the authors of fungal taxa are abbreviated according to Kirk & Ansell (1992) and Kirk et al. (2004).

Because many species have been published under different names, a thesaurus of synonyms is separately listed with references to the correct names used in the main list. A list of excluded records, providing reasons for their exclusion, is also appended.

Results

The complete checklist is available on: <http://www.mycotaxon.com>. In the current first version, 1537 correct names of larger basidiomycete species recognized as occurring in Bulgaria are accompanied by an index of synonyms representing 1020 species and infraspecific taxa based on literature records from Bulgaria. Another 157 taxa representing doubtful, confused or erroneously recorded or illegitimate names are listed as excluded.

Acknowledgements

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Literature cited

- Assyov B, Denchev CM. 2004. Preliminary checklist of *Boletales* s. str. in Bulgaria. *Mycologia Balcanica* 1: 195–208.
- Denchev CM, Bakalova GG. 2002. Centenary review of the fungal diversity investigations in Bulgaria. Bulgarian-Swiss Biodiversity Conservation Programme, Sofia. 71 pp. (In Bulgarian)
- Denchev CM, Petrova RD. 2005. Fungal diversity of Mt Strandzha (SE Bulgaria). 69–76, in N. Chipev (ed.), Challenges of establishment and management of a trans-border biosphere reserve between Bulgaria and Turkey in Strandzha Mountain. UNESCO-Bulgarian Academy of Sciences Workshop, Bourgas, Bulgaria, 10–13 November 2005. Bulgarian Academy of Sciences, Sofia.
- Denchev C, Gyosheva M, Bakalova G, Fakirova V, Petrova R, Dimitrova E, Sameva E, Stoykov D, Assyov B, Nikolova S. 2006. Fungal diversity of the Rhodopes (Bulgaria). 81–131, in P. Beron (ed.), Biodiversity of Bulgaria. Vol. 3. Biodiversity of Western Rhodopes (Bulgaria and Greece). I. Pensoft & Natl. Mus. Natur. Hist., Sofia.
- Denchev CM, Fakirova VI, Gyosheva MM, Petrova RD. 2007. Macromycetes in the Pirin Mts (SW Bulgaria). *Acta Mycologica* 42: 21–34.
- Fakirova VI, Gyosheva MM, Denchev CM. 2002. Checklist of the macromycetes of Central Balkan Mountain (Bulgaria). 25–38, in N. Randjelović (ed.), Proceedings of the Sixth Symposium on Flora of Southeastern Serbia and Adjacent Territories, Sokobanja, Yugoslavia, 4–7 July 2000. Vuk Karadžić, Niš, Yugoslavia.
- Georgiev S. 1906. Contribution to the diatoms, fungi, ferns and vascular plants in Bulgaria. *Godishnik na Sofiiskiia Universitet* 2: 83–123. (In Bulgarian)
- Kirk PM, Ansell AE. 1992. Authors of fungal names. International Mycological Institute, CABI, Wallingford.
- Kirk PM et al. 2004. Authors of fungal names. CABI Bioscience, Wallingford. Electronic version: <http://www.speciesfungorum.org/AuthorsOfFungalNames.htm>.
- Petrova A. 2001. Biosystematic and floristic studies in Bulgaria for the period 1993–2001. 27–46, in D. Temniskova (ed.), Proceedings of the Sixth National Conference of Botany, Sofia, 18–20 June 2001. Sofia University “St. Kliment Ohridski” Press, Sofia. (In Bulgarian)

Three new records of brown parmelioid lichens from the Tibetan Plateau

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Abstract—Three brown parmelioid lichens from the Tibetan Plateau are recorded as new to China: *Melanelixia albertana*, *M. subaurifera* and *Melanohalea gomukhensis*.

Keywords —Asia, Yunnan, Sichuan, lichenized fungi, taxonomy

Introduction

Both *Melanelixia* species and *Melanohalea* species have been placed in the genus *Melanelia* Essl. in its original sense. Based on molecular, chemical, and morphological data, Blanco et al. (2004) segregated *Melanelixia* and *Melanohalea* from *Melanelia*. *Melanelixia* is characterized by often lacking pseudocyphellae and by containing lecanoric acid as the primary medullary constituent (Blanco et al. 2004, Esslinger 1977). *Melanohalea* is morphologically characterized by an upper surface usually with pseudocyphellae, by a non-pored epicortex, and by a medulla containing depsidones or lacking secondary compounds (Blanco et al. 2004, Esslinger 1977).

Worldwide, *Melanohalea* includes twenty known species (Zhao et al. 2009) and *Melanelixia* nine species (Wang et al. 2008). In China, seven *Melanelixia* species (*M. fuliginosa*, *M. glabra*, *M. glabroides*, *M. huei*, *M. subargentifera*, *M. subvillosella*, *M. villosella*; Wang et al. 2009) and nine *Melanohalea* species (*M. exasperata*, *M. exasperatula*, *M. elegantula*, *M. lobulata*, *M. olivacea*, *M. olivaceoides*, *M. poeltii*, *M. subelegantula*, *M. septentrionalis*; Wang et al. 2009, Zhao et al. 2009) have been recorded.

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During our study on the lichen flora of the Tibetan Plateau, *Melanelixia albertana*, *M. subaurifera*, and *Melanohalea gomukhensis* were found in China for the first time. This means that all known species of *Melanelixia* have now been recorded in China.

Materials and methods

The specimens studied were collected from the Tibetan Plateau, China, and are preserved in SDNU (Lichen Section of Botanical Herbarium, Shandong Normal University). The morphology of the lichen specimens was examined using a stereo microscope (COIC XTL7045B2) and a microscope (OLYMPUS CX21). Lichen substances in all specimens cited were identified using the standardized thin layer chromatography techniques (Culberson 1972). Photos were taken under OLYMPUS SZX12 with DP70.

The new records

1. *Melanelixia albertana* (Ahti) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 881 (2004) FIG.1 A
 = *Parmelia albertana* Ahti, Bryologist 72: 236 (1969)
 = *Melanelia albertana* (Ahti) Essl., Mycotaxon 7(1): 47 (1978)

This species is characterized by the mainly corticolous habit, the moderate lobes (2–4 mm broad), the lack of pseudocyphellae, isidia and pycnidia, the marginal and labriform soralia, the granular and whitish soredia, the presence of cortical hairs, the lack of apothecia, the black lower surface, the moderate rhizina, and the presence of lecanoric acid in the medulla (PD–, K–, C+ rose red). The presence of marginal and labriform soralia distinguishes *Melanelixia albertana* from all other *Melanelixia* species. Both *M. albertana* and the related *M. subargentifera* have cortical hairs and soralia. However, *M. subargentifera* soralia are laminal, marginal, and punctiform.

Melanelixia albertana has been reported from North America and Russia (Esslinger 1977, Urbanavichene & Urbanavichus 1998). New to China.

SPECIMEN EXAMINED: CHINA. Sichuan, Kangding Co., Mt. Paomashan, alt. 2700m, on bark, 2 Nov. 2008, H.Y. Wang, 20084069, 20084070, 20084071, 20084072, 20084073 (SDNU).

2. *Melanelixia subaurifera* (Nyl.) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 882 (2004) FIG.1 B
 = *Parmelia subaurifera* Nyl. Flora, Jena 56: 22 (1873)
 = *Melanelia subaurifera* (Nyl.) Essl., Mycotaxon 7(1): 48 (1978)

This species is characterized by the mainly corticolous habit, the broad lobes (2–6 mm), the obscure pseudocyphellae, the presence of soralia or isidia or

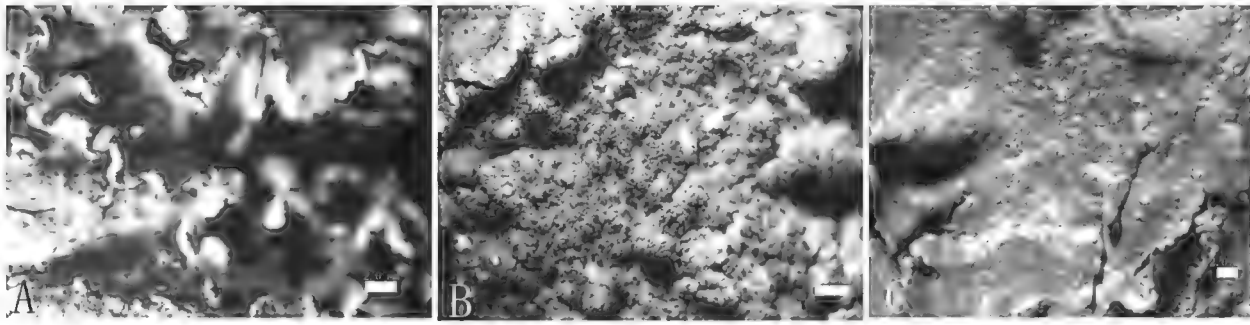


FIGURE 1 Scale bar = 1 mm. A. *Melanelixia albertana*, showing the marginal and labriform soralia (H.Y. Wang, 20084073); B *Melanelixia subaurifera*, showing the fine and simple isidia developed from the pseudocyphellae (H.Y. Wang, 20084133); C *Melanohalea gomukhensis*, showing the granular to isidioid soredia developed from the pseudocyphellae (H.Y. Wang, 20083584).

both, the lack of cortical hairs, the rare apothecia and pycnidia, the acerose to narrowly claviform conidia, the black lower surface, the moderate rhizina, and the presence of lecanoric acid in the medulla (PD–, K–, C+ rose red). The soralia (if present) with granular to isidioid soredia are laminal, punctiform, and developed from the pseudocyphellae. The isidia (if present) are cylindrical, not or infrequently branched, and usually arise within or between the soralia. *M. subaurifera* is commonly easy to recognize, since it is the only *Melanelixia* species with both isidia and soredia. However, our specimen was not sorediate, only isidiate. Its isidia are fine ($0.1\text{--}0.25 \times 0.02\text{--}0.06$ mm), simple, and developed from the distinct pseudocyphellae. Within *Melanelixia*, only two species, *M. subaurifera* and *M. fuliginosa* are isidiate and lack cortical hairs. However, *M. fuliginosa* lacks pseudocyphellae, has larger ($0.2\text{--}1 \times 0.05\text{--}0.1$ mm), branched isidia with distinct knob at the end. In addition to lecanoric acid, *M. fuliginosa* also contains another lichen substance (TE-12; Esslinger 1977).

Melanelixia subaurifera has been reported from North America, Europe, Greenland, Iceland, and Iran (Blanco et al. 2004, Esslinger 1977, Gelting 1956, Orange 1990, Sohrabi et al. 2007). New to China.

SPECIMEN EXAMINED: CHINA. Sichuan, Kangding Co., Mt. Paomashan, alt. 2700m, on bark, 2 Nov. 2008, H.Y. Wang, 20084133 (SDNU).

3. *Melanohalea gomukhensis* (Divakar, Upreti & Elix) O. Blanco, A. Crespo, Divakar, Essl., D. Hawksw. & Lumbsch, Mycol. Res. 108(8): 882 (2004) FIG.1 C
= *Melanelia gomukhensis* Divakar, Upreti & Elix, Mycotaxon 80: 356 (2001)

This species is characterized by a corticolous habit, broad lobes (4–6 mm broad), distinct pseudocyphellae, black and granular to isidioid soredia developed from pseudocyphellae, black lower surface, moderate rhizina, lack of soralia, isidia, pycnidia, and apothecia, and the presence of fumarprotocetraric and protocetraric acids in the medulla (K+ pale yellow-brown, C–, KC–, PD+ orange-red). The presence of soredia, pseudocyphellae, and fumarprotocetraric and

protocetraric acids distinguishes *M. gomukhensis* from all other *Melanohalea* species. Both *M. gomukhensis* and *M. olivaceoides* are similar in producing soredia and fumarprotocetraric and protocetraric acids (PD+ orange-red), but *M. olivaceoides* has punctiform soralia and lacks pseudocyphellae.

Melanohalea gomukhensis has been reported from India (Divakar et al. 2001). New to China.

SPECIMEN EXAMINED: CHINA. Yunnan, Shangri-la Co., Tianshengqiao, alt. 3500m, on bark, 2 Nov. 2008, H.Y. Wang, 20083584 (SDNU).

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Literature cited

- Blanco O, Crespo A, Divakar PK, Esslinger TL, Hawksworth DL, Lumbsch HT. 2004. *Melanelixia* and *Melanohalea*, two new genera segregated from *Melanelia* (*Parmeliaceae*) based on molecular and morphological data. *Mycological Research* 108(8): 873–884.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Divakar PK, Upreti DK, Elix JA. 2001. New species and new records in the lichen family *Parmeliaceae* (*Ascomycotina*) from India. *Mycotaxon* 80: 355–362.
- Esslinger TL. 1977. A chemosystematic revision of the brown *Parmeliae*. *Jour. Hattori Bot. Lab.* 42: 1–211.
- Gelting P. 1956. *Parmelia subaurifera* Nyl. and *P. fraudans* (Nyl.) Nyl. in Greenland. *Friesia* 5(3–5): 240–246.
- Orange A. 1990. New or interesting lichens and lichenicolous fungi from Iceland. *Acta Botanica Islandica* 10: 37–44.
- Sohrabi M, Ahti T & Urbanavichus G. 2007. Parmelioid lichens of Iran and the Caucasus Region. *Mycologia Balcanica*. 4: 21–30.
- Urbanavichene IN, Urbanavichus GP. 1998. *Melanelia albertana* (Lichenes) A new for Russia species from the southern Baikal region. *Botanicheskii Zhurnal* 83(1): 130–131.
- Wang HY, Chen JB, Wei JC. 2008. A new species of *Melanelixia* (*Parmeliaceae*) from China. *Mycotaxon* 104: 185–188.
- Wang HY, Chen JB, Wei JC. 2009. A phylogenetic analysis of *Melanelia tominii* and four new records of brown parmelioid lichens from China. *Mycotaxon* 107: 163–173
- Zhao ZT, Meng FG, Li HM, Wang HY. 2009. A new species of *Melanohalea* (*Parmeliaceae*) from the Tibetan Plateau. *Mycotaxon* 108: 347–352.

A new species of *Dictyostelium* from Tibet, China

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Abstract — A new species, *Dictyostelium microsorocarpum*, was isolated from meadow soil in Tibet, China. It is characterized by its small sorocarps, multicellular sorophores and relatively large sori. Detailed descriptions and photographs are provided based on the holotype.

Key words — dictyostelids, taxonomy

Introduction

The genus *Dictyostelium* of Mycetozoa was established by Brefeld (1869). Up to now, more than 60 species of *Dictyostelium* have been described in the world (Kirk et al. 2008).

The dictyostelids may be divided into three groups based on the size of their sorocarps: large, ≥ 10 mm; intermediate, 3–9 mm; and small, < 2 mm (Cavender et al. 2005). During our investigation of dictyostelids in Tibet, a new small species of *Dictyostelium*, *D. microsorocarpum* was obtained from meadow soil in Linzhi, Tibet. It differs from all described small species (Raper 1984, Cavender et al. 2005, Vadell et al. 2007) of *Dictyostelium* in having a combination of small sorocarps, multicellular sorophores, a disproportionate number of large sori to small sorocarps. The descriptions, photographs, and a discussion of this species are given below.

Materials and methods

Samples for isolation of dictyostelids were collected during August 2007 from Linzhi and Lhasa, Tibet. The isolation, cultivation and observation procedures are the same as those described previously (He et al. 2008).

The type specimen is preserved in the Herbarium of the Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

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Taxonomy

Dictyostelium microsorocarpum Yu Li & Xiao-Lan He, sp. nov.

FIG. 1

MYCOBANK MB 512589

Sorocarpia in cultura in agaro nonnutricio cum *Escherichia coli* ad 22°C solitaria, erecta vel semi-erecta, eramosa, habitu valida, parva, 0.16–1.5 mm longa, plerumque 0.8–1.2 mm (media 0.98 mm). Sorophora plerumque robusta, non angustata ex basis ad apicem in segmento erecta, plerumque multicellularia, 10–20 µm in diametro. Bases clavatae multicellulares, prostratae ab sorogena provecta elongata producentes, plerumque e strato cellularum singulo compositae, interdum sustinentes, segmenta erecta multicellularia, segmenta prostrata erectis segmentis angustiora. Apices multicellulares. Sori globosi vel subglobosi, hyalino-albi, comparate magni, plerumque 64–136 µm in diametro. Sporae ellipticae vel oblongae, glabrae, sine polaribus granulis, plerumque 6.0–7.6 × 3.6–4.4 µm. Aggregationes cellularum radiatae, magnitudine non uniformes, rivulus convergens quum sorogena formantia. Plerumque quaque aggregatio sorogenum singulum producens. Sorogena hyalinoalba, apices conspicuae, plerumque cylindricae, apice rotundato-conicae. Sorogena serotina curviora. Myxamoebae non distinctae, comparate magnae, plerumque 19.3–23.1 × 11.6–16.9 µm, contractiles vel vacuolam pabulorum prominentes, forma irregularis. Myxamoebae non aggregatae microcystam facientes. Microcystae rotundae vel subrotundae, magnitudine non uniformes, plerumque 5–7 µm in diametro, interdum dominantes in cultura; macrocystae non observatae.

HOLOTYPE: MR003. Isolated from meadow soil, Linzhi, Tibet. Deposited at the Herbarium of the Mycological Institute of Jilin Agricultural University (HMJAU), Changchun.

ETYMOLOGY: Latin, *microsorocarpum*, referring to the small sorocarps.

When cultured on non-nutrient agar with *Escherichia coli* at 22°C, sorocarps solitary, erect or semi-erect, unbranched, stout in appearance, small, commonly 0.16–1.5 mm, mostly 0.8–1.2 mm (average 0.98 mm). Sorophores commonly robust, without conspicuous tapering from the bases to the tips in erect structures, generally consisted of several tiers of cells, mostly 10–20 µm in diameter. Bases clavate or having lengthened prostrate segments on the culture, sometimes with supporters, the club-shaped bases multicellular, the 1-celled prostrate bases produced by the advancing sorogen and narrower than the stand-up segments of sorophores. Terminal segment of sorophore multicellular. Sori globose or subglobose, colorless or white, comparatively large, commonly 64–136 µm in diameter. Spore elongate, elliptical or nephroid, colorless, having no polar granules, commonly 6.0–7.6 × 3.6–4.4 µm. Cell aggregations radiate in pattern, variable in dimensions, streams tending to converge as sorogens being formed, commonly each aggregation producing a single sorogen. Sorogens colorless, with conspicuous tips, mostly bullet-shaped. Late sorogens tending to curve. Myxamoebae not distinctive, relatively large, commonly 19.3–23.1 × 11.6–16.9 µm, with contractile and food vacuoles prominent, irregular in shape. Myxamoebae becoming microcysts when not aggregated. Microcysts sometimes dominant in the culture, globose or nearly globose, variable in size, mostly 5–7 µm in diameter; macrocysts not observed.

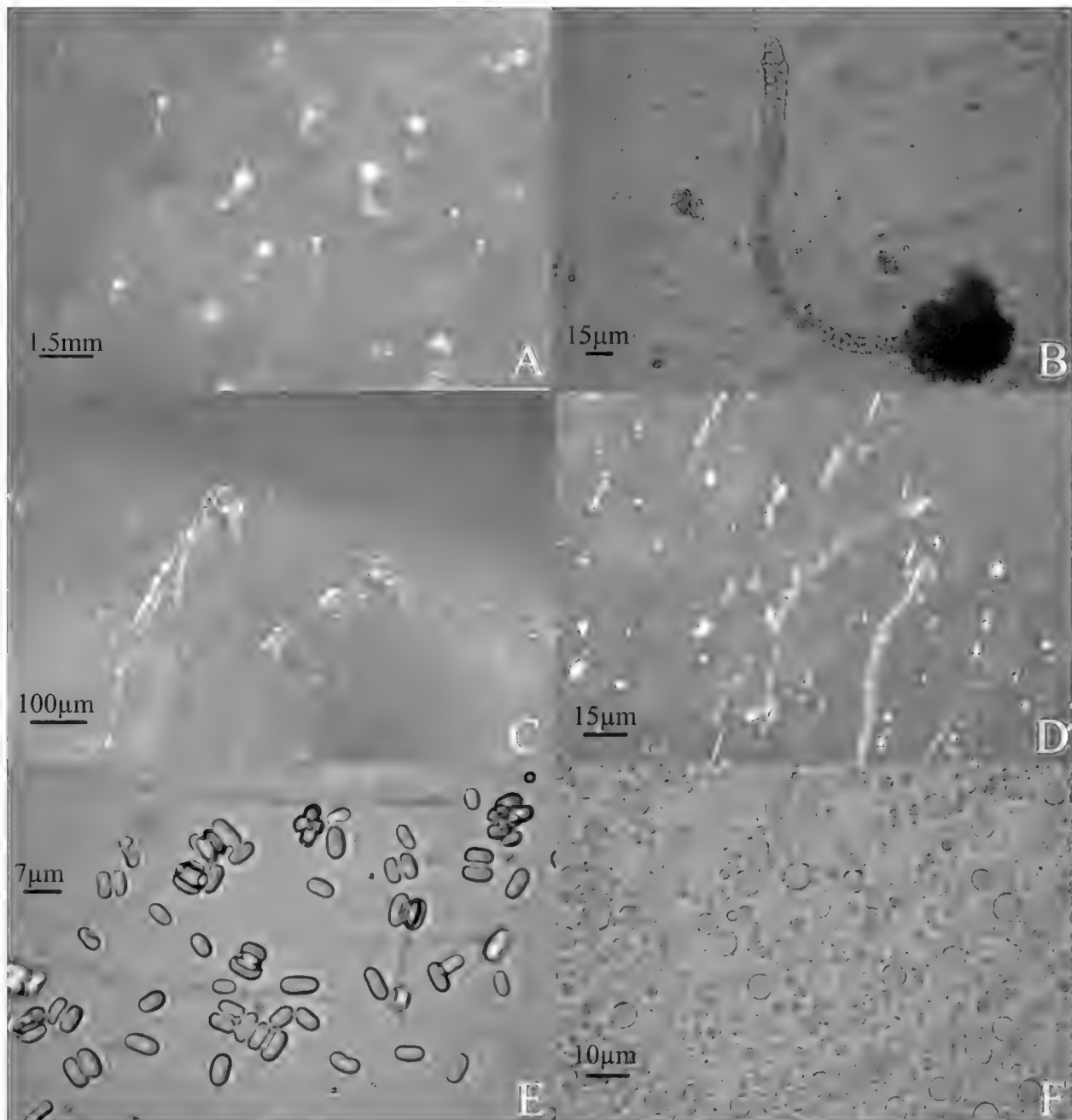


FIG. 1 *Dictyostelium microsorocarpum*

A, Sorocarps; B, Multicellular sorophore; C, Aggregations;
D, Sorogens; E, Elliptical spores; F, Microcysts.

COMMENTS: The present cellular slime mold is a different small species of dictyostelids. The sorophores of the small dictyostelids commonly consist of single tiers of cells except in basal portions, while the present small species has typical multicellular sorophores. *Dictyostelium microsorocarpum* resembles *D. macrocephalum* (Hagiwara et al. 1985) in the disproportionate number of large sori to small sorocarps. However, *D. macrocephalum* has thin sorophore tips and neither microcysts nor macrocysts observed during the course of culture (Hagiwara et al. 1985), while *D. microsorocarpum* has multicellular sorophore tips and numerous microcysts. Furthermore, *D. macrocephalum*

produces a larger sorocarp than that of *D. microsorocarpum*. The present new species never exceeds 2 mm in size, while *D. macrocephalum* ranges 0.25–2.25 (–9.0) mm.

Dictyostelium microsorocarpum can be easily distinguished from *D. antarcticum* (Cavender et al. 2002) in that the spores of the latter species have prominent consolidated polar to sub-polar granules, which *D. microsorocarpum* lacks.

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Literature cited

- Brefeld O, 1869. *Dictyostelium mucoroides*. Ein neuer Organismus und der Verwandtschaft der Myxomyceten. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 7: 85–107, pls. 1–3.
- Cavender JC, Stephenson SL, Landolt JC, Vadell EM. 2002. Dictyostelid cellular slime moulds in the forests of New Zealand. New Zealand J. Bot. 40:235–264.
- Cavender JC, Vadell E, Landolt JC, Stephenson SL. 2005. New species of small dictyostelids from the Great Smoky Mountains National Park. Mycologia 97(2): 493–512.
- Hagiwara H, Yeh ZY, Chien CY. 1985. *Dictyostelium macrocephalum*, a new dictyostelid cellular slime mold from Taiwan. Bull. Natn. Sci. Mus., B 11(3): 103–108.
- He XL, Li Y. 2008. Three new records of dictyostelids in China. Mycosystema 27(4): 532–537.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the fungi. Wallingford: CABI.
- Raper KB. 1984. The Dictyostelids. Princeton University Press.
- Vadell EM, Cavender JC. 2007. Dictyostelids living in the soils of the Atlantic Forest, Iguazu region, Misiones, Argentina: description of new species. Mycologia 99(1): 112–124.

***Arthrobotrys scaphoides* from China and Europe with a phylogenetic analysis including the type strain**

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Abstract —*Arthrobotrys scaphoides* is recorded for the first time from China. The strain is compared with European strains (including the type strain) morphological and molecular methods. The species is illustrated by photographs and line drawings. ITS sequence phylogenetic analysis places three *A. scaphoides* strains in the same monophyletic group with *A. conoides*, a species strongly different in morphology.

Key words —predacious fungi, rDNA gene

Introduction

Arthrobotrys Corda was first established for the type species, *A. superba* (Corda 1839), which is characterized by the formation of two-celled conidia on denticles in a whorled arrangement at the tip and the nodes of the simple, erect, septate conidiophore. The genus was long used in Corda's sense for nematode trapping hyphomycetes independent of the type of trapping organ present. Schenck et al. (1977) expanded the genus to include species with aseptate and multicelled conidia. Scholler et al. (1999) subsequently limited *Arthrobotrys* to only those species with adhesive networks, a concept we follow here.

In a survey of nematode-trapping fungi in China, we isolated a species of predacious hyphomycetes with rather large conidia and three-dimensional adhesive networks. Simultaneously, a European culture representing obviously

[‡] These authors contributed equally to this work.

TABLE 1. Morphological comparison of three *Arthrobotrys scaphoides* isolates with other nematophagous species possessing ± fusiform conidia.

SPECIES	CONIDIA			REFERENCE
	SIZE	# OF SEPTA	SHAPE	
<i>A. scaphoides</i> (YMF1.01895)	36.6-79.3 × 11.0-17.5	1-6, mainly 2-3	elongate fusiform	This paper
<i>A. scaphoides</i> (CBS 226.52)	26-83 × 12-17	1-3	elongate fusiform	Peach 1952
<i>A. scaphoides</i> (H.B. 6972)	50-86 × 13-16	2-4, mainly 3	elongate fusiform	This paper
<i>A. gampospora</i> (Drechsler) S. Schenck et al.	25-76 × 7-16	4	elongate fusiform	Liu & Zhang 1994
<i>Dactylellina copepodii</i> (G.L. Barron) M. Scholler et al.	56-97 × 8.5-16	(1-)4(-6)	fusiform	Barron 1990
" <i>Dactylella</i> " <i>dianchiensis</i> Y.E. Hao & K.Q. Zhang	37.5-100 × 10-17.5	1-7, mainly 2-5	elongate fusoid to fusoid-clavate	Hao et al. 2004
<i>A. mangrovispora</i> Swe et al.	25-50 × 12-24	0-3, mainly 2	top-shaped to fusiform	Swe et al. 2008
<i>A. microscaphoides</i> Xing Z. Liu & B.S. Lu 1993	23-39 × 8 -15.5	0-3, mainly 2	top-shaped	Liu & Lu 1993

the same species was identified as *A. scaphoides*, a rather rarely reported taxon.

Our primary aims of this study were (i) to examine morphological differences between the two *A. scaphoides* isolates, (ii) to explore the ITS rDNA sequence similarity between the two isolates and the type strain, and (iii) to investigate molecular relationships between *A. scaphoides* and other nematode-trapping fungi.

Materials and methods

Origin and isolation of strains, documentation

Soil samples from Gansu Province, China, were sprinkled on corn meal agar (CMA, 20 g corn meal, 18g agar, 40 mg streptomycin, 30 mg ampicillin, 1000 ml distilled water) plates inoculated with the free-living nematode *Panagrellus redivivus* Goodey at 25°C. In a collection of *Orbilia* aff. *auricolor* (A. Bloxam ex Berk. & Broome) Sacc., on *Scirpus maritimus* from the Netherlands (deposited in the private herbarium of H.O. Baral—H.B.), *A. scaphoides* grew as contaminant with *A. oudemansii* M. Scholler et al. in an ascospore isolate of the *Orbilia*. Conidia of *A. scaphoides* were placed on half-strength CMA (without antibioticum, Rubner 1996) to which unidentified nematodes were later added. After incubation of about one month, samples were examined under a dissecting microscope. Isolates were taken and cultivated on CMA at 28°C and 22°C, respectively.

Morphological characters were observed and photographed with an Olympus BX51 and a Zeiss Standard 20 microscope. Trapping organs were induced by adding about 100 nematodes into a 1 × 1 cm square slot at the margins of the colony where the agar was removed.

DNA extraction, PCR amplification, and sequencing

Three *A. scaphoides* strains (including the type strain) were sequenced in the present study. Genomic DNA in the Chinese strain was extracted from the mycelium collected from single-spore cultures growing on cellophane membrane on PDA according to Jeewon et al. (2002). Primer pairs ITS5 & ITS4 (White et al. 1990) were used to amplify the complete internal transcribed spacer (ITS, including 5.8S). The PCR amplification parameters were: 1 minute initial denaturation at 95°C, followed by 30 cycles of 1 minute denaturation at 94 °C, 1 minute primer annealing at 50°C, 1.5 minutes extension at 72°C, and a final 10 minute extension at 72°C. The purified PCR products were directly sequenced on both strands with the same primers that were used for amplification.

The two European strains (including the ex-type culture, CBS 226.52) were extracted and amplified according to Hagedorn & Scholler (1999), with the deviation of using primers NS7 to NL4 and purifying with QIAquick Purification Kits. The result was bi-directionally sequenced using Amersham Thermo-Sequenase IRD-labeled primers (NS7, ITS5, ITS1, ITS4, NL1, and NL4; White & al. 1990) on a LI-COR 4000L automated DNA sequencer.

Phylogenetic analysis

DNA sequences were aligned with additional sequences obtained from GenBank using ClustalX 1.83 (Thompson et al. 1997) and adjusted manually using BioEdit sequence alignment editor. Parsimony analysis was run in PAUP* version 4.0b10 (Swofford 2002), with the following settings: gaps treated as missing data, all characters equally weighted, using heuristic searches with TBR (tree-bisection-reconnection) as branch-swapping algorithm, initial 'MaxTrees' setting at 100; bootstrap values were generated using the settings 1000 replications. GenBank accession numbers can be found in Fig. 4. Sequence similarity analysis among our *Arthrobotrys scaphoides* strains and other phylogenetic related species was performed by DNAMAN software. A maximum-parsimony analysis was performed based on ITS region of *A. scaphoides* and related predacious fungi (FIG. 4), the ITS rDNA alignment has 29 taxa, 559 aligned nucleotides, all characters were given equal weight, *Neurospora crassa* was selected as outgroup.

Results

Taxonomy

Arthrobotrys scaphoides (Peach) S. Schenck, W. B. Kendr. & Pramer,

Can. J. Bot. 55: 984 (1977)

= *Dactylaria scaphoides* Peach, Trans. Br. Mycol. Soc. 35: 19 (1952)

= *Woroninula scaphoides* (Peach) Mekht., Khishchnye
nematofagovye Griby – Gifomitsety: 113 (1979)

= *Monacrosporium scaphoides* (Peach) Xing Z. Liu &
K.Q. Zhang, Mycol. Res. 98: 865 (1994)

FIG. 1–3

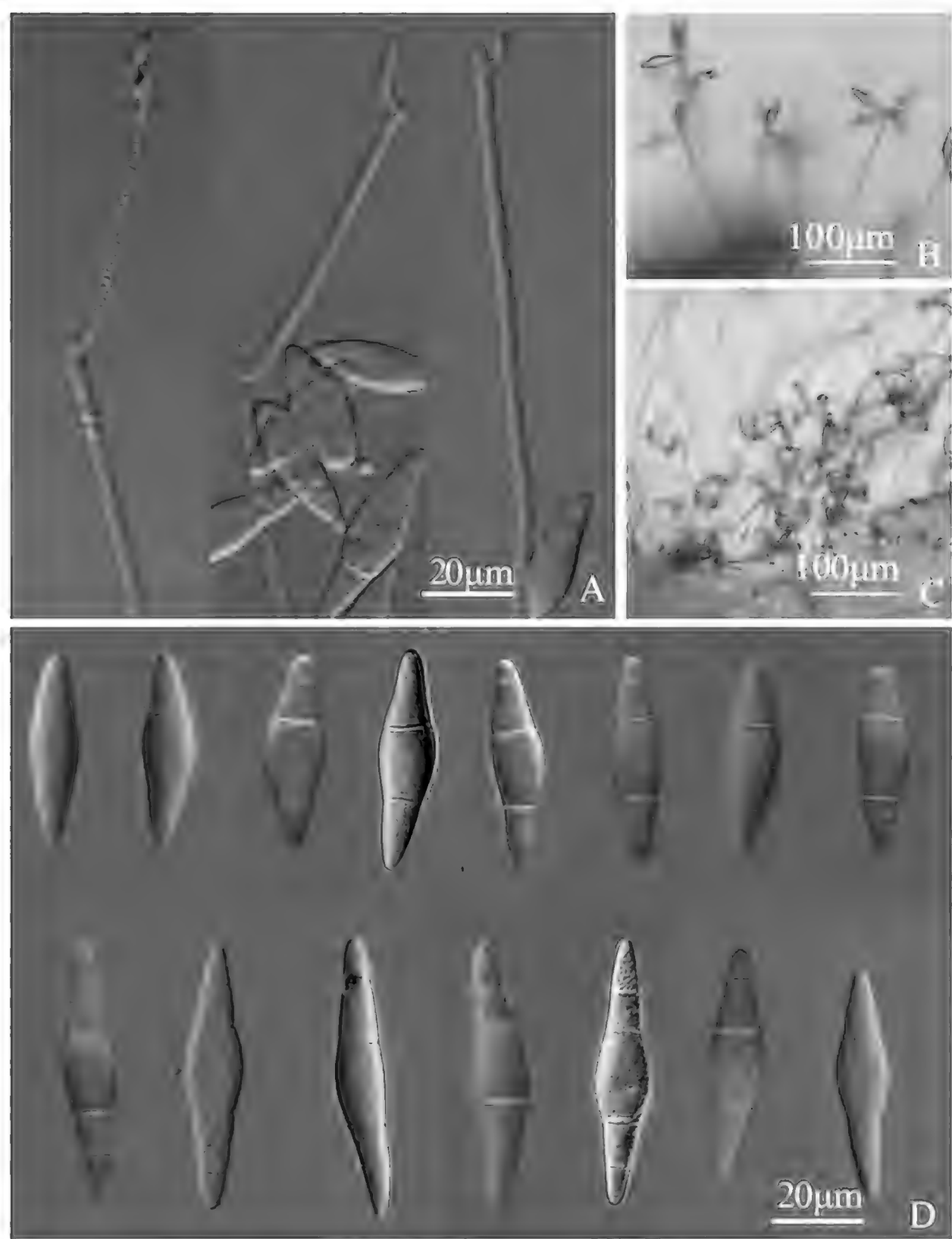


FIG. 1. A. *scaphoides* (YMF1.01895) A. Conidiophores. B. Conidiophores with conidia. C. Adhesive networks. D. Conidia (living state).

ORIGIN OF ISOLATES: **PR China**, Gansu Province, Jiuquan city, alt. 2450 m, from soil, under *Malus asiatica* Nakai (*Rosaceae*), from a private plantation. VIII.2006, YMF 1.01895, permanent slide culture (YMF 1.01895); **The Netherlands**: Zeeland, old harbour facing the Hertoginpolder, Verdronken Land van Saeftinghe, most eastern part, alt. 0 m, on previous year's leaves of *Scirpus maritimus* L. (*Cyperaceae*), 23.III.2001,

G. Van Ryckegem (H.B. 6972b, dry specimen, associated with *Arthrobotrys oudemansii* M. Scholler et al. and its teleomorph).

Mycelium spreading, growing slowly, reaching 30 mm in diameter at 28°C after 12 days. Vegetative hyphae hyaline, septate, 4–6 µm wide. Conidiophores erect, hyaline and septate, unbranched, 4.5–5.6 µm wide at base and tapering to a width of 4–4.5 µm, at a distance of 80 to 200 µm from the base producing

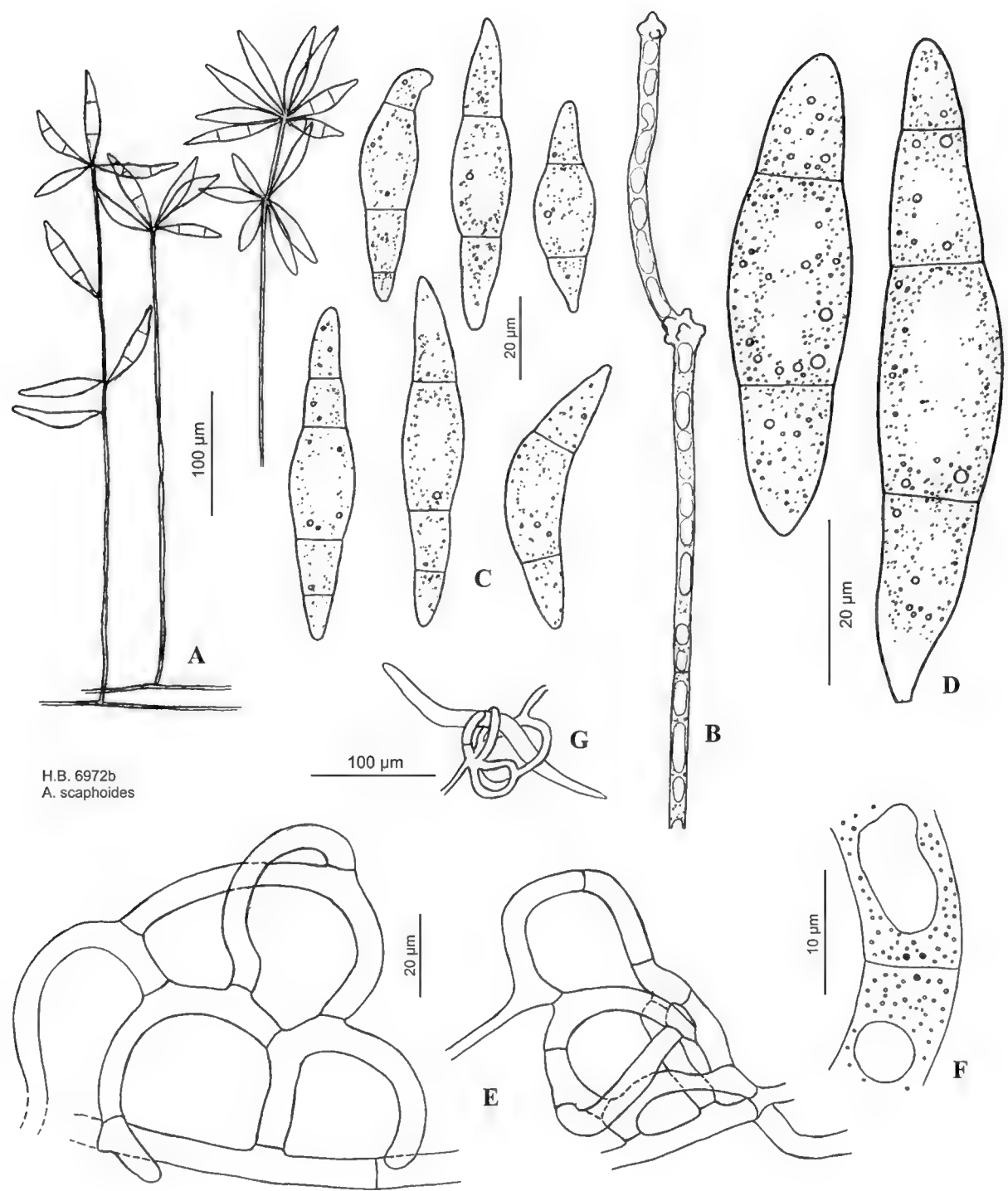


FIG. 2. *A. scaphoides* (H.B. 6972b) A. Conidiophores with conidia. B. Conidiophore. C–D. Conidia. E. Adhesive networks. F. Detail of adhesive networks showing vacuoles, three Woronin bodies close to septum, and many minute lipid bodies. G. Nematode trapped by adhesive network. All figures in living state.

1–6 conidia, occasionally up to 10 conidia, in a loose capitate arrangement, then following repeated elongation often giving successively rise to up to 3 additional conidial clusters by branching at or just below slightly swollen warted nodules, producing more or less geniculate conidiophores up to 365–430 μm long. Conidia hyaline, 36.6–79.3 (57.0) \times 11.0–17.5 (14.0) μm (Chinese strain), (50–)60–80(–86) \times (13–)14–15(–16) μm (Dutch strain, both vital state in water), fusiform, not or slightly curved, 1–6-septate, mainly 2–3 septate, the proportion of conidia with 1, 2, 3, 4, 5 and 6 septa was 1.3%, 48.8%, 37.5%, 10%, 1.3% and 1.3% respectively (Chinese strain), 2–3(–4)-septate (Dutch strain), middle cell mostly distinctly longer and wider than other cells. Three-dimensional adhesive networks observed when nematodes were added. Chlamydospores not observed in cultures.

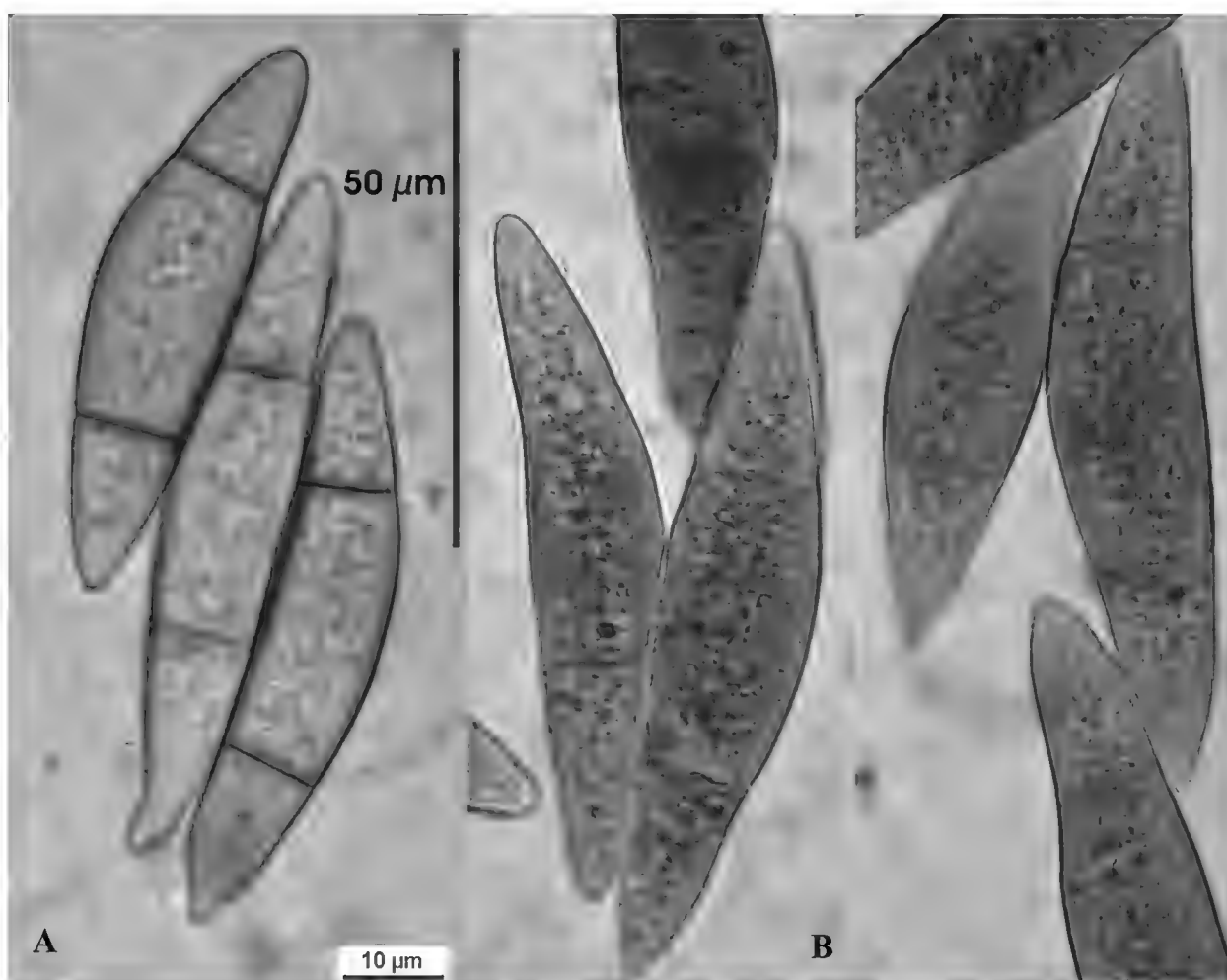


FIG. 3. *A. scaphoides* (H.B. 6972b) A–B. Conidia, vital state, stained by aqueous Cresyl blue (A) and Lugol's solution (B).

Phylogenetic analysis

We compared rDNA sequences from our fungus with related species bearing different predacious devices. The maximum parsimony analysis of the ITS rDNA sequences indicates that the investigated species grouped together

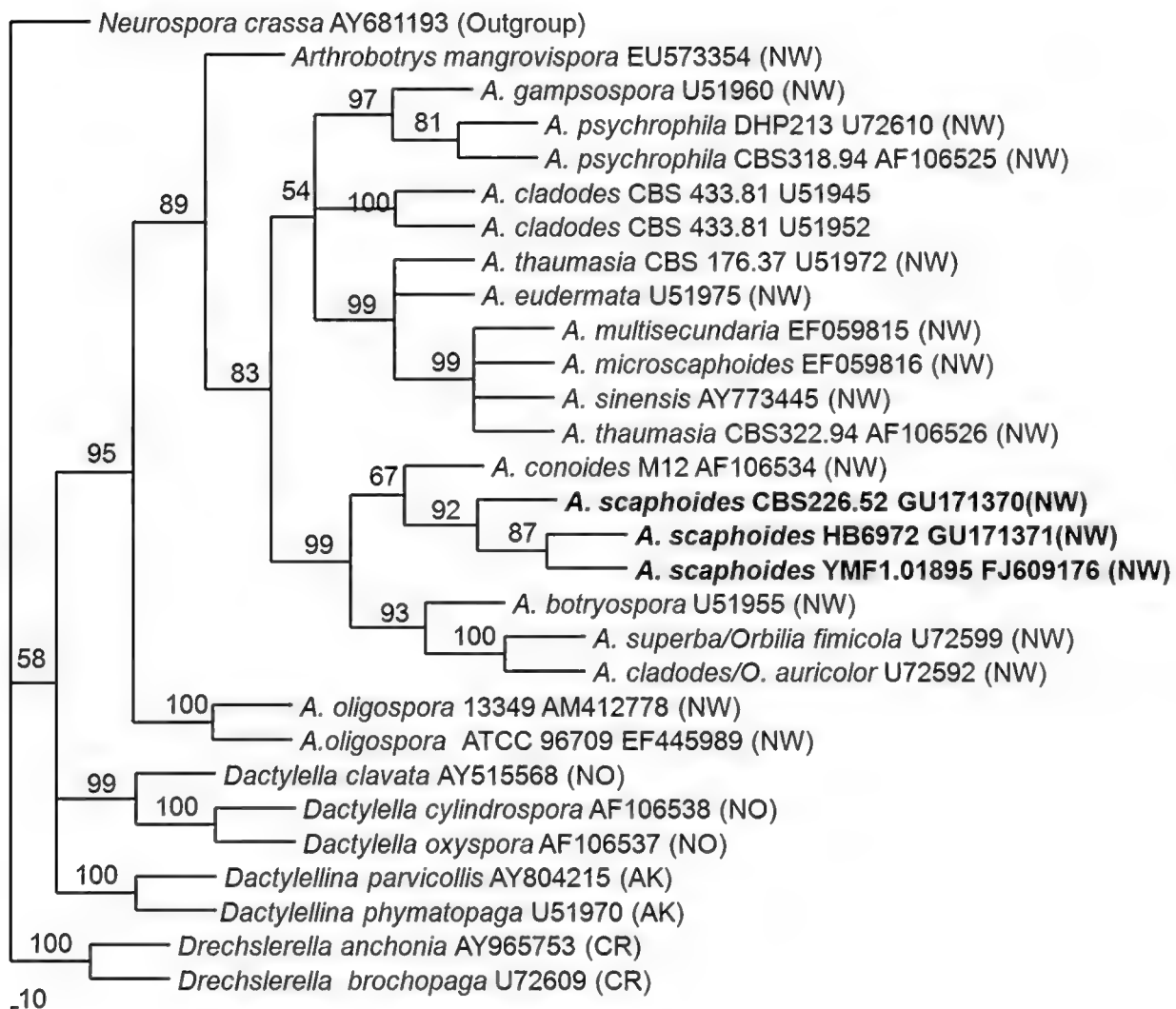


FIG. 4. Most parsimonious phylogenetic tree generated from a heuristic search based on the alignment of the ITS region sequences of predacious fungi. Numbers above lines represent bootstrap values from 1000 replicates on all parsimony-informative characters (only bootstrap >50% shown). The accession number of sequences obtained from GenBank are shown. CR = constricting rings, NW = networks, NO = no-trapping advice, AK= adhesive knobs. Tree length = 823, consistency index (CI) = 0.6452, homoplasy index (HI) = 0.3548, retention index (RI) = 0.7579, rescaled consistency index (RC) = 0.4890.

in accordance with the results of Scholler et al. (1999). The ingroup separated into four major clades based on unique types of trapping organs: one includes the species producing constricting rings (*Drechslerella*), one adhesive knobs (*Dactylellina*), one adhesive networks (*Arthrobotrys*), and the fourth clade includes species without known trap organs (*Dactylella*).

Within *Arthrobotrys* the three investigated *A. scaphoides* strains clustered together with 92% bootstrap support, forming a clade together with an *A. conoides* strain (bootstrap value 67%). This group forms with 99% bootstrap support a sister clade to the group including *A. superba*, *A. cladodes* var. *macroides* Drechsler, and *A. botryospora* G.L. Barron. Most remaining

Arthrobotrys species included in our analysis clustered in a clade sister to the two former groups.

Within *A. scaphoides*, the Chinese strain shows a closer relationship to strain H.B. 6972: the ITS rDNA sequence analysis demonstrates that there is 99.6% similarity between them (2 nucleotide variance in ITS1-5.8s-ITS2 region), but 98.7% between the Chinese strain and CBS 226.52 (type strain, 7 nucleotide variances), and 99.0% between the strain from *Scirpus* and the type strain from *Typha* (5 nucleotide variance). Between the Chinese strain of *A. scaphoides* and other morphologically close species, the similarity is 84.2% to *A. microscaphoides* Xing Z. Liu et B.S. Lu, 84.9% to *A. thaumasia* (Drechsler) S. Schenck et al., (CBS 322.94), and 85.7% to *A. gampospora*.

Discussion

Arthrobotrys scaphoides was described by Peach (1952) as *Dactylaria scaphoides* from an aquatic habitat, with macroconidia $26\text{--}83 \times 12\text{--}17 \mu\text{m}$, (1–)2(–3) septate. Shorter conidiophores emerging from these conidia produced much smaller, non-septate microconidia ($14\text{--}22 \times 5\text{--}8.5 \mu\text{m}$). Apart from the type collection (UK, England, Surrey, decaying leaves of *Typha latifolia* L., 1950, M.P. Peach, CBS 226.52), the rare reports of *A. scaphoides* include collections from Ireland (mixed deciduous leaf litter, 1982, Gray 1984), Africa (Morocco, 1200 m alt., from soil, 1993, A. Rubner, CBS 396.93), and S. America (Brazil, Minas Gerais, 426 m alt, from sheep faeces on a pasture, 1996, Saumell et al. 2000). Our Chinese specimen was isolated from the rhizosphere soil of a fruit tree (*Malus asiatica*) planted in arid areas of northwest China, while the Dutch strain was isolated from a monocotyledon substrate (*Scirpus*) in an environment comparable to the type strain. Ranges of conidium length and width in the Chinese strain are similar to those reported by Peach (1952) (TABLE 1), although the width range extended higher and the length range lower than those cited in the protologue. Variation in the Dutch strain was comparatively low, with conidial length at the upper limit. Microconidia were not observed in either of the two strains. Conidia with more than 4 septa were occasionally seen in the Chinese strain CMA culture but were absent in the two other strains, and 1-septate conidia were absent in the Dutch strain. The predacious ability using three-dimensional networks was found to be distinctly high in our fungus: the growth of networks and mycelium became particularly fast once the nematodes were added, and most nematodes were trapped by the network in only two days. Hao et al. (2005) found that nematode-trapping hyphomycete species common in terrestrial soil are also represented in aquatic environments. The same dimorphic habitat is found in the nematophagous fungus *A. scaphoides*, which has the capacity to occupy a broad range of habitats.

Among *Arthrobotrys* species with fusiform to top-shaped conidia, *A. gampospora* most resembles *A. scaphoides*. It differs from the latter in the conidia being slightly narrower and partly more distinctly curved and in forming chlamydospores in pure culture. However, our phylogenetic analysis of an *A. gampospora* strain from the type geographic region (Florida, U.S.A.) shows that it is not very closely related to *A. scaphoides*.

Both Liu & Lu (1993) and Swe et al. (2008) cite a strong similarity between *A. microscaphoides* and *A. mangrovispora* Swe et al. and *A. scaphoides*. However, *A. microscaphoides* has shorter, top-shaped conidia (also found in, e.g., *A. thaumasia*), and *A. mangrovispora* somewhat shorter and wider conidia of more variable shape (i.e., top-shaped but also elongate-fusoid as in *A. scaphoides*). Both differ by forming chlamydospores. Our ITS sequence analysis shows both species as phylogenetically distant to *A. scaphoides* (FIG. 4).

Dactylellina copepodii (G.L. Barron) M. Scholler et al., which also has conidia very similar to *A. scaphoides* in both size and shape, forms only one conidium at the conidiophore apex and captures copepods by adhesive knobs. The fusoid to fusoid-clavate conidia of “*Dactylella*” *dianchiensis* Y.E. Hao & K.Q. Zhang also resemble *A. scaphoides* conidia but differ in having up to 5(–7) septa and in lacking a larger central cell. Furthermore, its arcuate adhesive hyphal branches suggest this species more likely belongs to the genus *Dactylellina* (near the former *Gamsylella* species).

Classification based on conidial morphology is not supported by our phylogenetic tree, confirming the results of Scholler et al. (1999). For instance, the *A. scaphoides* clade, which contains *A. conoides* with much shorter, obovoid, 1-septate conidia, is closest to the *A. superba* clade where all members produce obovoid 0–1-septate conidia. On the other hand, the *A. scaphoides* clade is more remote to the clade containing *A. gampospora*, *A. microscaphoides*, and *A. thaumasia* — with fusoid to top-shaped conidia with more than one septum — as well as species with cylindric-ellipsoid to obovoid, 1-septate conidia, like *A. cladodes*. This is astonishing because *A. gampospora* conidia can easily be confused with those of *A. scaphoides*. Even more astonishing is the similarity of the *A. scaphoides* conidia to those of *Dactylellina copepodii*, which belongs in *Dactylellina* — as genetically demonstrated by Scholler et al. (1999).

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resource for microorganism strains in Yunnan Province.

Literature cited

- Barron GL. (1990). A new predatory hyphomycete capturing copepods. *Canadian Journal of Botany* 68: 691-696.
- Corda ACJ. 1839. *Pracht-Flora europäischer Schimmelbildungen*. Leipzig, Germany.
- Gray NF. 1984. Ecology of nematophagous fungi: predatory and endoparasitic species new to Ireland. *Irish Naturalists' Journal* 21: 337-341.
- Hagedorn G, Scholler M. 1999. A reevaluation of predatory orbiliaceous fungi. I. Phylogenetic analysis using rDNA sequence data. *Sydowia* 51: 27-48.
- Hao YE, Luo J, Zhang KQ. 2004. A new aquatic nematode-trapping hyphomycete. *Mycotaxon* 89: 235-239.
- Hao Y, Mo MH, Su HY, Zhang KQ. 2005. Ecology of aquatic nematode-trapping hyphomycetes in southwestern China. *Aquatic Microbial Ecology* 40: 175-181.
- Jeewon R, Liew ECY, Hyde KD. 2002. Phylogenetic relationships of *Pestalotiopsis* and allied genera inferred from ribosomal DNA sequences a morphological characters. *Molecular Phylogenetics and Evolution* 25: 378-392.
- Liu XZ, Lu BS. 1993. Two new species of *Monacrosporium* from China. *Mycosystema* 6: 65-69.
- Liu XZ, Zhang KQ. 1994. Nematode-trapping species of *Monacrosporium* with special reference to two new species. *Mycological Research* 98: 862-868.
- Peach M. 1952. Aquatic predacious fungi. II. *Transactions of the British Mycological Society* 35: 19-23.
- Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. *Studies in Mycology* 39: 1-134.
- Saumell CA, Padilha T, Santos CdeP. 2000. Nematophagous fungi in sheep faeces in Minas Gerais, Brazil. *Mycological Research* 104: 1005-1008.
- Schenck S, Kendrick WB, Pramer D. 1977. A new nematode-trapping hyphomycete and a reevaluation of *Dactylaria* and *Arthrobotrys*. *Canadian Journal of Botany* 55: 977-985.
- Scholler M, Hagedorn G, Rubner A. 1999. A reevaluation of predatory orbiliaceous fungi. II. A new generic concept. *Sydowia* 51: 89-113.
- Swe A, Jeewon R, Pointing SB, Hyde KD. 2008. Taxonomy and molecular phylogeny of *Arthrobotrys mangrovispora*, a new marine nematode-trapping fungal species. *Botanica Marina* 51: 331-338.
- Swofford DL. 2002. *PAUP*: Phylogenetic Analysis Using Parsimony (*and other methods)*. Version 4.0b10. Sinauer Associates, Sunderland, Massachusetts U. S. A.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 24: 4876-4882.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *PCR protocols: a guide to methods and applications* (Innis MA, Gelfand DA, Sninsky JJ, White TJ, eds). Academic Press, San Diego. C. A., U.S.A.: 315-322.

A new species of *Hygrocybe* in section *Firmae* from Western Ghats, India

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Abstract — *Hygrocybe natarajanii*, a new species of *Hygrocybe* section *Firmae* collected from the Uppangala forest of Western Ghats of Karnataka, India is described and illustrated. Both macro- and microscopical features of this new species are compared with similar or closely related taxa viz., *Hygrocybe boothii*, *H. firma*, *H. neofirma*, *H. brunneosquamosa*, and *H. brunneosquamulosa*.

Key words — *Agaricales*, *Basidiomycota*, *Hygrophoraceae*, macrofungi

Introduction

The genus *Hygrocybe* (Fr.) P. Kumm. in the family *Hygrophoraceae* is well represented throughout the world. *Hygrocybe* species with dimorphic spores and basidia, which are classified in section *Firmae*, are primarily tropical and subtropical in distribution. Section *Firmae* includes a wide diversity of forms including an alamelate species from Ecuador (Læssøe & Boertmann 2008). Neotropical species of *Hygrocybe* in section *Firmae* were studied by Cantrell & Lodge (2001) and Lodge & Ovrebo (2008), while paleotropical species with dimorphic spores and basidia were described by Berkeley & Broome (1871) and Corner (1936) and Young (2002) and revised by Pegler & Fiard (1978), Pegler (1986), and Singer (1957). In India, twenty-two species of *Hygrocybe* have been reported from different regions (Manjula 1983, Natarajan et al. 2005). The most notable record of the species of *Hygrocybe* from India was provided by Leelavathy et al. (2006), who described 25 species in Kerala State, including 10 new species. Only one of the species found by Leelavathy et al. (2006), *H. alwisii*, was in section *Firmae*. During our studies in the Western Ghats region from Karnataka State we collected a specimen that differs macro-

and microscopically from previously described *Hygrocybe* species in section *Firmae*. This species is described below as new to science.

Materials and methods

The description and illustrations are based on the type specimen collected from the Uppangala forest of Western Ghats of Karnataka. Handmade sections were obtained from the dried specimens, later revived in 3% KOH, and mounted in 2% Phloxine. Approximately 50 basidiospores obtained from a spore print were measured; extreme values are given in parentheses. The type specimen is deposited in the Herbarium of Madras University Botany Laboratory (MUBL). The colour terminology used is that of Kornerup & Wanscher (1978).

Taxonomy

Hygrocybe natarajanii Senthil. & Kumaresan, sp. nov.

PLATES 1, 2

MYCOBANK MB 515447

Pileus 2–3 cm diametro, convexus, depressus, ultimus foramina, luteolus, superficie tomentosus, atrorubineus, margine non-striatus. *Lamellae* decurrentes, luteolus, 4.5 mm latae, subdistantes, crassus, duabus ordinibus lamellularum intermixtae, margine concolori. *Stipes* 5–14 cm × 2–5 mm, superficie lutea pallida, cylindricus, compressus, laevis, cavus. *Contextus pilei* hyphis 3–6 µm diametro, hyalinae, parietibus tenuibus. *Sporae* dimorphae; macrospora $12.3 \pm 1.2 \times 8.5 \pm 0.5$ [(10–)10.5–14(–15) × (7.5–)8–9(–9.5) µm, $Q = 1.4$], ellipsoideae, hyalinae, parietibus tenuibus, laevis, guttulis refractives; microspora (4.5–)5–7(–8.5) × 3.5–5.5(–6) ($6.0 \pm 0.8 \times 4.0 \pm 0.5$) µm, $Q = 1.5$, ellipsoideae, similis ad macrospora. *Basidia* dimorpha; macrobasidia 55–68.5 × 11.5–15.5 µm, clavata, 4-spore, hyalinae, guttulis numerosis; microbasidia 37–44.5 × 5.5–8.5 µm, cylindrico-clavata, similis ad macrobasidia. *Margo lamellaris* fertilis. *Cystidia* nulla. *Trama hymenophoralis* regularis, ex hyphis 62–279 × 10–42 µm. *Pileipellis cutis* ex hyphis repentibus 3–12 µm diametro, composita, trichodermis, est hyphis 15–102 × 3–12.5 µm, cylindricus, septatus. *Fibulis* abundantibus.

HOLOTYPE: INDIA, Karnataka State, Maanadukka, Uppangala Forest, on ground (soil), G. Senthilarasu & V. Kumaresan (MUBL 3428).

ETYMOLOGY: This species is named in honour of late Prof. K. Natarajan, Centre for Advanced Studies in Botany, University of Madras, India.

Pileus 2–3 cm diam., convex, broadly, shallowly depressed at the disk, finally perforated with age; surface dry and covered by dark ruby red (12F8), tomentose squamules (especially noticeable towards the margin) on light yellow (3A5) ground; margin regular, decurved, crenate, not striate. *Lamellae* subdecurrent to decurrent, pale yellow (3A3), ≤ 4.5 mm broad near the stipe, thick, subdistant, with lamellulae of two lengths; edge concolorous, even. *Stipe* 5–14 cm × 2–5 mm, equal, slightly attenuated towards the apex, cylindric with a slightly compressed apex, fistulose; surface light yellow (3A5), smooth. *Context* ≤ 2 mm thick at the disk.



PLATE 1. *Hygrocybe natarajanii* basidiomata (holotype).
a. In situ in Uppangala forest. b. Detail of tomentose squamules on pilei.
Photos G. Senthilarasu

Basidiospores dimorphous: macrospores $12.3 \pm 1.2 \times 8.5 \pm 0.5$ [(10–)10.5–14 (–15) \times (7.5–)8–9(–9.5) μm , $Q = 1.4$], ellipsoid, hyaline, thin-walled, smooth with few refractive guttules; microspores $6.0 \pm 0.8 \times 4.0 \pm 0.5$ [(4.5–)5–7(–8.5) \times 3.5–5.5(–6) μm , $Q = 1.5$], ellipsoid, similar to macrospores. Basidia dimorphous: macrobasidia $55\text{--}68.5 \times 11.5\text{--}15.5$ μm , broadly clavate, bearing four large sterigmata $\leq 10.5 \times 3.5$ μm , hyaline, with numerous refractive guttules; microbasidia $37\text{--}44.5 \times 5.5\text{--}8.5$ μm , narrowly cylindric-clavate, bearing four large sterigmata $\leq 8 \times 2$ μm , similar to macrobasidia. Lamellar edge fertile. Cystidia absent. Hymenophoral trama regular, with parallel, hyaline, thin-walled, 3–7.5 μm diam hyphae intermixed with large (62–279 \times 10–42 μm), thin-walled, hyaline, narrowly stalked cylindric-clavate to ventricose elements. Subhymenial layer well developed, ≤ 10 μm wide, interwoven. Pileal surface a cutis of radially parallel hyphae, 3–12 μm diam, inflated to 25 μm diam, forming a disrupted trichodermial palisade underneath the tomentose squamules; individual elements 15–102 \times 3–12.5 μm , of unbranched, cylindric, septate hyphae, with brown intracellular pigment. Pileus trama tightly interwoven, thin-walled, hyaline hyphae, 3–6 μm diam, inflated to 13 μm diam. Clamp-connections present on most hyphae.

HABITAT - On ground, gregarious or caespitose, in wet evergreen forest, 12° 30' N and 79° 39' W, 500 masl.

DISCUSSION: The characteristic features of *H. natarajanii* are the presence of dark ruby tomentose squamules over a small, light yellow perforated pileus, very long and slender stipe, caespitose growth, and strongly dimorphic spores and basidia. Dimorphic spores and basidia are characteristic features of section *Firmae*. The disrupted tomentose to squamulose pileal surface is due to the development of uplifted fascicles of long, unbranched, cylindric, septate hyphae with brown intracellular pigment.

Hygrocybe boothii A.M. Young (Young 2002) resembles *H. natarajanii* in having a somewhat similarly sized and shaped basidiome with a scaly pileus. However, its bright red pileus and short (4.5–8.5 cm) red stipe distinguish it from *H. natarajanii* with its yellow pileus densely covered with ruby red squamules and its longer (5–14 cm) yellow stipe. Besides the morphological characters, *H. natarajanii* has smaller macro- (12.3×8.5 μm vs 14.3×10.6 μm) and microspores (6×4 μm vs 7.5×5.1 μm) and somewhat narrower microbasidia (5.5–8.5 μm vs 9–9.5 μm) than *H. boothii*.

Hygrocybe natarajanii resembles *H. firma* (Berk. & Broome) Singer (Pegler 1986), first described from Sri Lanka and also reported from Australia (Young 2005) and Malaysia (Corner 1936). Both *H. firma* and *H. natarajanii* have a convex to applanate or depressed, tomentose to scurfy squamulose pileus and yellow lamellae. In addition, their macrospores, macrobasidia, microspores,

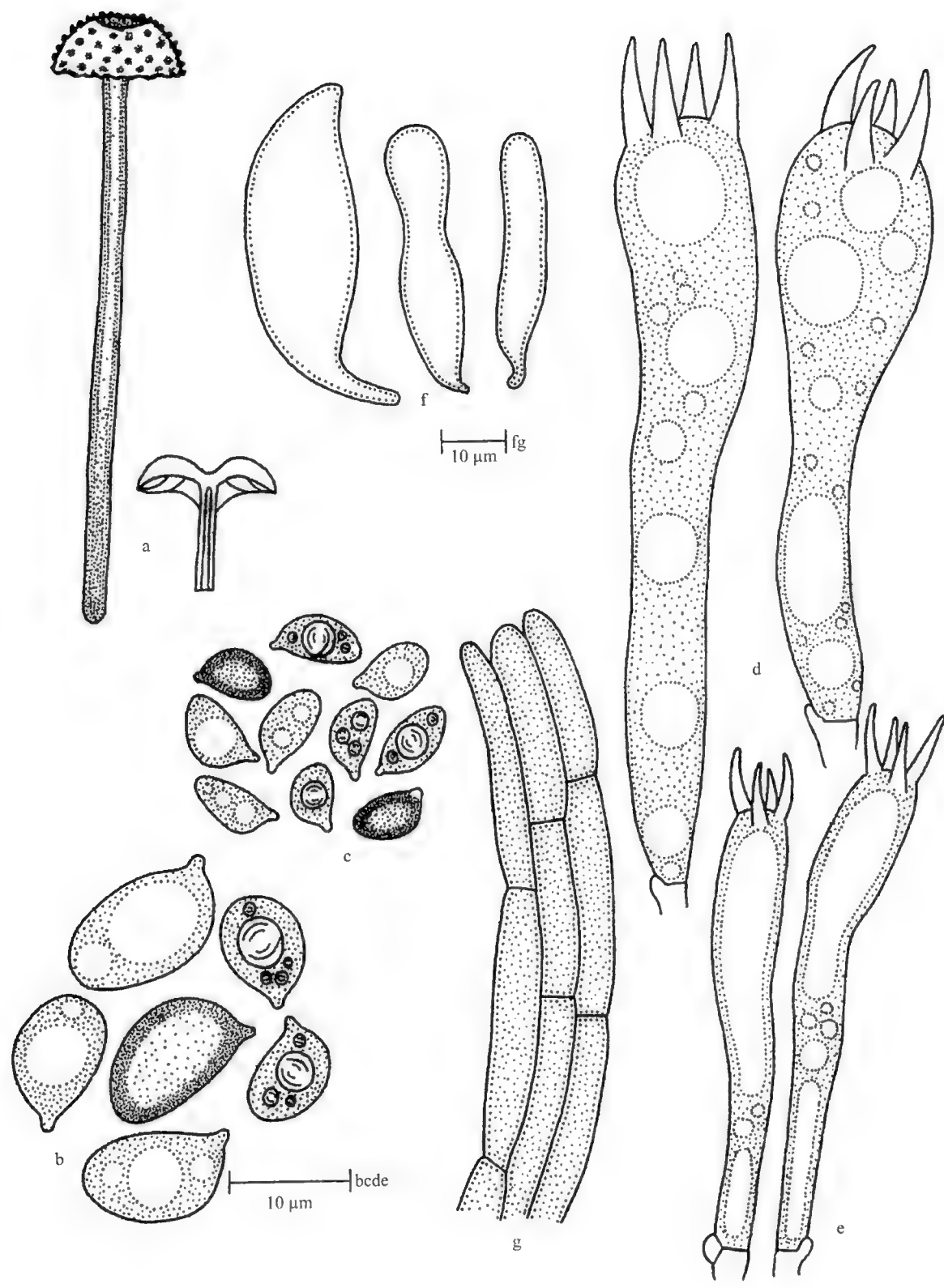


PLATE 2. *Hygrocybe natarajanii* (holotype).
a. Habit $\times 1$, and longitudinal section. b. Macrobasidiospores. c. Microbasidiospores.
d. Macrobasidia. e. Microbasidia. f. Tramal elements. g. Epicuticular hyphae.
Scale bar = 10 μm .

and microbasidia are of similar size. However, the *H. firma* type collection (Thwaites 880 from Peradeniya, Sri Lanka) clearly differs from *H. natarajanii* in having a larger (1–4 cm vs 2–3 cm) minutely squamulose orange red to scarlet red pileus lacking brown pigments in the trichoderm and a short (3–8 cm vs 5–14 cm), concolorous or paler stipe. Besides the colour and size differences, the spores of *H. firma* are more distinctly dimorphic in shape (with oblong ellipsoid to ellipso-cylindric macrospores and ovoid to broadly ellipsoid microspores), while in *H. natarajanii* both macro- and microspores are similarly ellipsoid.

Hygrocybe natarajanii closely resembles *H. neofirma* S.A. Cantrell & Lodge (Cantrell & Lodge 2001) and *H. brunneosquamosa* Lodge & S.A. Cantrell (Cantrell & Lodge 2001) in the tomentose pileus, a trichodermial pileipellis with brown contents in the trichodermial elements, and similarly sized and shaped microspores. However, *H. neofirma* and *H. brunneosquamosa* basidiomes are larger than those of *H. natarajanii* and with a broader aspect (a 1–2 pileus diameter to stipe length ratio rather than >2–3) and a shorter stipe (2.2 cm in *H. neofirma* and 3.3 cm in *H. brunneosquamosa* vs 5–14 cm in *H. natarajanii*). *Hygrocybe brunneosquamosa* is further distinguished by its squarrose grayish brown to cinnamon brown pileus and brown lamellae. Microscopically, *H. natarajanii* macrospores are smaller (10–15 µm vs 13.5–19 µm in *H. neofirma* and 15–21 µm in *H. brunneosquamosa*) and macrobasidia (55–68.5 µm vs 32–56 µm) and microbasidia (37–44.5 µm vs 24–28 µm) are larger than in *H. brunneosquamosa*.

Hygrocybe natarajanii macroscopically resembles *H. brunneosquamulosa* Leelav. et al. (Leelavathy et al. 2006) described from Western Ghats of Kerala, India in having a convex, perforated, squamulose pileus and yellow lamellae and stipe. However, *H. brunneosquamulosa* is distinguished by olive brown to dark brown squamules on a yellowish brown ground, a shorter stipe (1.5–9 cm vs 5–14 cm), and an entire carpophore that turns black on drying. In addition, the absence of dimorphic spores and basidia clearly distinguishes *H. brunneosquamulosa* microscopically.

Acknowledgments

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Literature cited

- Berkeley MJ, Broome CE. 1871. The fungi of Ceylon. Journal of the Linnean Society. Botany 11: 494–567.
- Corner EJH. 1936. *Hygrophorus* with dimorphous basidiospores. Transactions of the British Mycological Society 20: 157–184.
- Cantrell SA, Lodge DJ. 2001. *Hygrophoraceae* (Agaricales) of the Greater Antilles: *Hygrocybe* subgenus *Pseudohygrocybe* section *Firmae*. Mycological Research 105: 215–224.
- Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. 3rd edn. Methuen and Co., Ltd., London. 243 p.
- Laessøe T, Boertmann D. 2008. A new alamellate *Hygrocybe* species from Ecuador. Mycological Research 112: 1206–1209.
- Leelavathy KM, Manimohan P, Arnolds EJM. 2006. *Hygrocybe* in Kerala State, India. Persoonia 19: 101–151.
- Lodge DJ, Ovrebo CL. 2008. First records of *Hygrophoraceae* from Panama including a new species of *Camarophyllus* and a new veiled species in *Hygrocybe* section *Firmae*. Fungal Diversity 32: 69–80.
- Manjula B. 1983. A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. Proceedings of Indian Academy of Sciences (Plant Science) 92: 81–213.
- Natarajan K, Kumaresan V, Narayanan K. 2005. A checklist of Indian agarics and boletes (1984–2002). Kavaka 33: 61–128.
- Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bulletin Additional Series XII.
- Pegler DN, Fiard JP. 1978. *Hygrocybe* sect. *Firmae* (Agaricales) in tropical America. Kew Bulletin 32: 297–312.
- Singer R. 1957. Fungi Mexicani, series prima – *Agaricales*. Sydowia 11: 354–374.
- Young AM. 2002. *Hygrocybe boothii* sp. nov., from northern Queensland. Australasian Mycologist 21: 114–116.
- Young AM. 2005. Fungi of Australia: *Hygrophoraceae*. ABRS, Canberra; CSIRO Publishing, Melbourne.

New and rare coelomycetes with appendage-bearing conidia from Pondoland, South Africa

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Abstract — During a mycological excursion to the Pondoland region of South Africa in 2008, six interesting anamorphic fungi with appendage-bearing conidia were isolated. They are *Bartalinia pondoensis*, *Crucellisporium umtamvunae*, and *Mycohypallage margaretae*, all of which are new to science, *Mycohypallage congesta* with a new observation of gelatinous basal appendage, *Mycotribulus mirabilis* on a new host plant, *Apodytes*, and *Chaetospermum camelliae*. Morphological characters are described and notes provided. The teleomorphic affinity of *C. umtamvunae* to the *Helotiales* is proposed based on DNA sequence data.

Key words — Maputaland-Pondoland-Albany (MPA), biodiversity hotspot, microfungi

Introduction

South Africa has a rich biological diversity, harbouring four of 34 biodiversity hotspots in the world (<http://www.biodiversityhotspots.org>). Among them is the Maputaland-Pondoland-Albany (MPA) center, which lies on the east coast of southern Africa, which shelters about 600 tree species, representing the highest tree richness of any known temperate forest and comprising 80% of South Africa's remaining forests (Silander 2001). As indicated by its name, the MPA consists of three areas — Maputaland (M) from southern Mozambique, Pondoland (P) in the middle, and Albany further south in South Africa's Eastern Cape Province (FIG. 1). The Pondoland forms the focus of this study and is home to approximately 1800 vascular plants, including more than 120 endemic species (Steenkamp et al. 2004). The Umtamvuna Nature Reserve (UNR), located near Port Edward in KwaZulu-Natal, South Africa, is a major conservation area of the Pondoland.

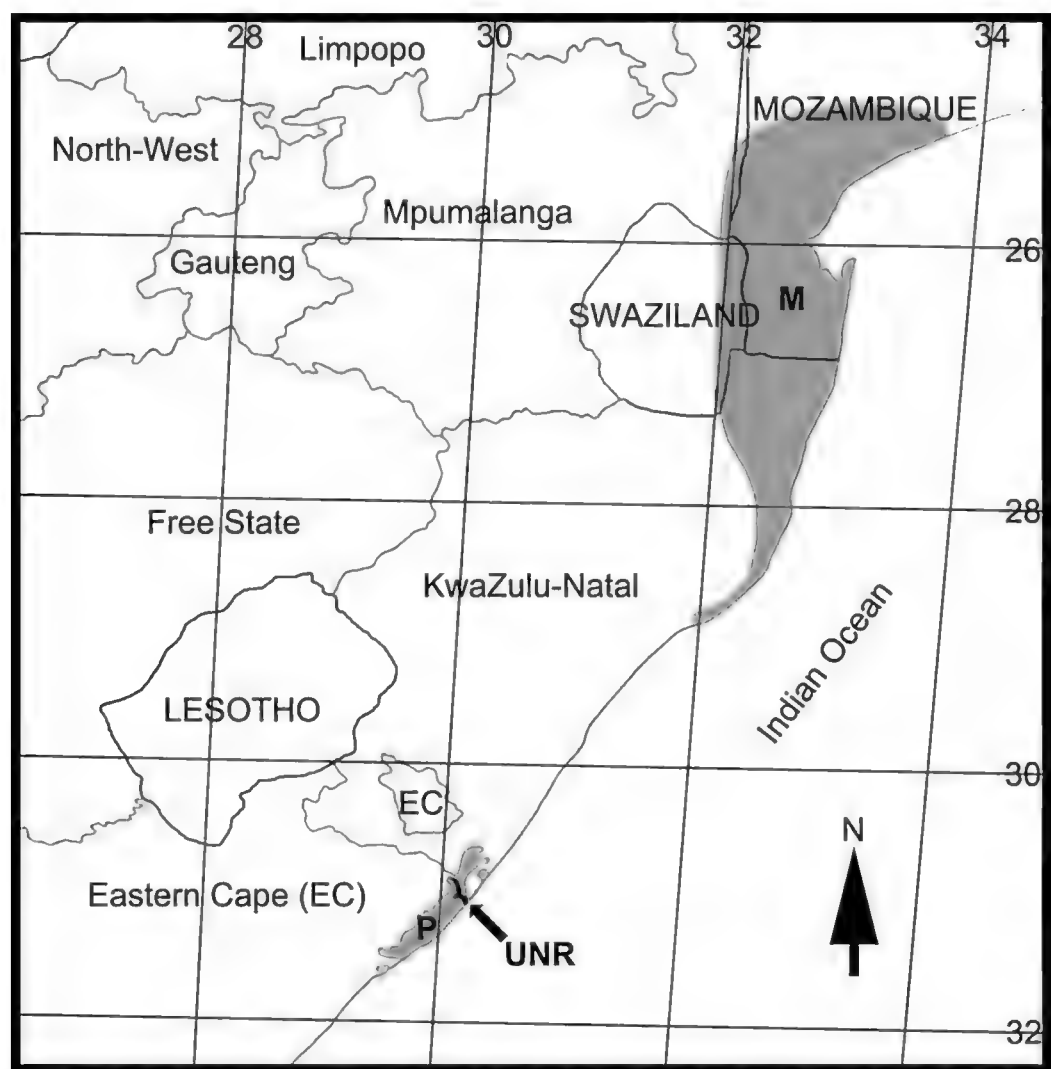


FIG.1. The location of the Maputaland-Pondoland-Albany center of biodiversity hotspot and the collection site. M—Maputaland region, P—Pondoland region, UNR—the Umtamvuna Nature Reserve.

The UNR is acknowledged for its floral richness and high level of endemism (Abbott & Van Wyk 2000). However, the UNR mycobiota has not drawn much attention: only 51 macrofungi and lichens were listed by Abbott & Van Wyk (2000). There have also been no surveys of the fungal diseases of plants, some of which could be caused by alien invasive pathogens.

This project was initiated to study plant pathogenic fungi in the UNR. During this pilot investigation several rare and new micro-fungi were encountered. These included six coelomycete fungi with conidial appendages that were associated with minor leaf spots or were dormant inside the healthy tissues. They are presented in this paper with full descriptions.

Materials and methods

The Umtamvuna Nature Reserve and “Red Desert” at Port Edward were visited in May 2008. In the UNR, two hiking-trails (i.e., Porcupine and Fish Eagle), were chosen based

on tree distribution and accessibility. Living leaves showing disease symptoms such as leaf spots or leaf necrosis and healthy asymptomatic leaves were collected.

Leaf spots with visible fungal structures were directly re-hydrated with a drop of sterile water. Asymptomatic specimens were re-hydrated in moisture chambers to induce the growth of fungi inside of the tissue. Fungi were isolated by removing fungal structures or oozing spores with a needle. Single spore isolation was established on 2% malt extract agar (MEA), supplemented with streptomycin. Reference cultures were deposited in the culture collection (CMW) of the Forestry and Agricultural Biotechnology Institute at the University of Pretoria, Pretoria, South Africa and the Centraalbureau voor Schimmelcultures (CBS), Utrecht, the Netherlands. Dried herbarium specimens and dried cultures were deposited at the National Collection of Fungi in South Africa (PREM).

Fungi were studied directly from plant material under a Zeiss Stemi SV6 dissecting microscope and a Zeiss Axioskop 2 Plus light microscope with differential interference contrast (DIC), bright field (BF), or phase contrast (PhC). Images were captured using an AxioCam ICc 3 camera mounted on the microscopes. Measurements were made of at least 30 structures whenever possible with the aid of Axiovision 4.5 software (AxioVs 40 V 4.6.3.0, Carl Zeiss Ltd., München, Germany). For spore dimensions, average \pm standard deviation was determined and measurements are presented with the extremes given in parentheses. A small piece of tissue containing conidiomata was prepared in Jung tissue freezing mediumTM for cross section and cut in 10–12 μ m thickness using a Leica CM1100 cryotome.

Culture characteristics were determined for each species in triplicate on 2% MEA plates. Cultures were incubated for 8–14 d at 25 C in the dark. Colour assignments were made using Rayner (1970).

Fungal colonies were established on MEA plates for extraction of total genomic DNA. Hyphae were harvested and freeze-dried. DNA extractions were done according to Möller et al. (1992). A region spanning the 3' end of the small subunit (SSU), internal transcribed spacers (ITS1, ITS2), the 5.8S gene and part of the large subunit (LSU) of the ribosomal operon were amplified with PCR using the primer set V9G and LR5 (de Hoog & Gerrits van den Ende 1998, Vilgalys & Hester 1990). PCR conditions and protocols were the same as those of Gryzenhout et al. (2004) except that 1U Taq DNA polymerase (FABI, University of Pretoria, South Africa) was used. The PCR amplicons were purified using Sephadex columns (Multiscreen HV, Millipore, Bedford, USA). They were sequenced using the same primers used for PCR, and internal primers ITS4 (White et al. 1990) and LR0R (Rehner & Samuels 1994) on an ABI 3100TM automated DNA sequencer and ABI PRISMTM Big Dye terminator. A sequencing reaction kit was used according to manufacturer's instructions (Perkin-Elmer, Applied BioSystems, Foster City, USA).

Contigs were created from the sequence data and aligned in CLCBio Main Workbench ver 5.5 (CLCBio, Aarhus, Denmark). Sequence data were deposited in GenBank and accession numbers for each species are given with the respective descriptions. Approximate phylogenetic placements were determined with the BLAST search option of the National Center for Biotechnology Information (NCBI) and the suggested identities are discussed in the descriptive notes below each of the treated species.

Results and discussion

Bartalinia pondoensis Marinc., Gryzenh. & M.J. Wingf., *sp. nov.*

FIGS. 2–5

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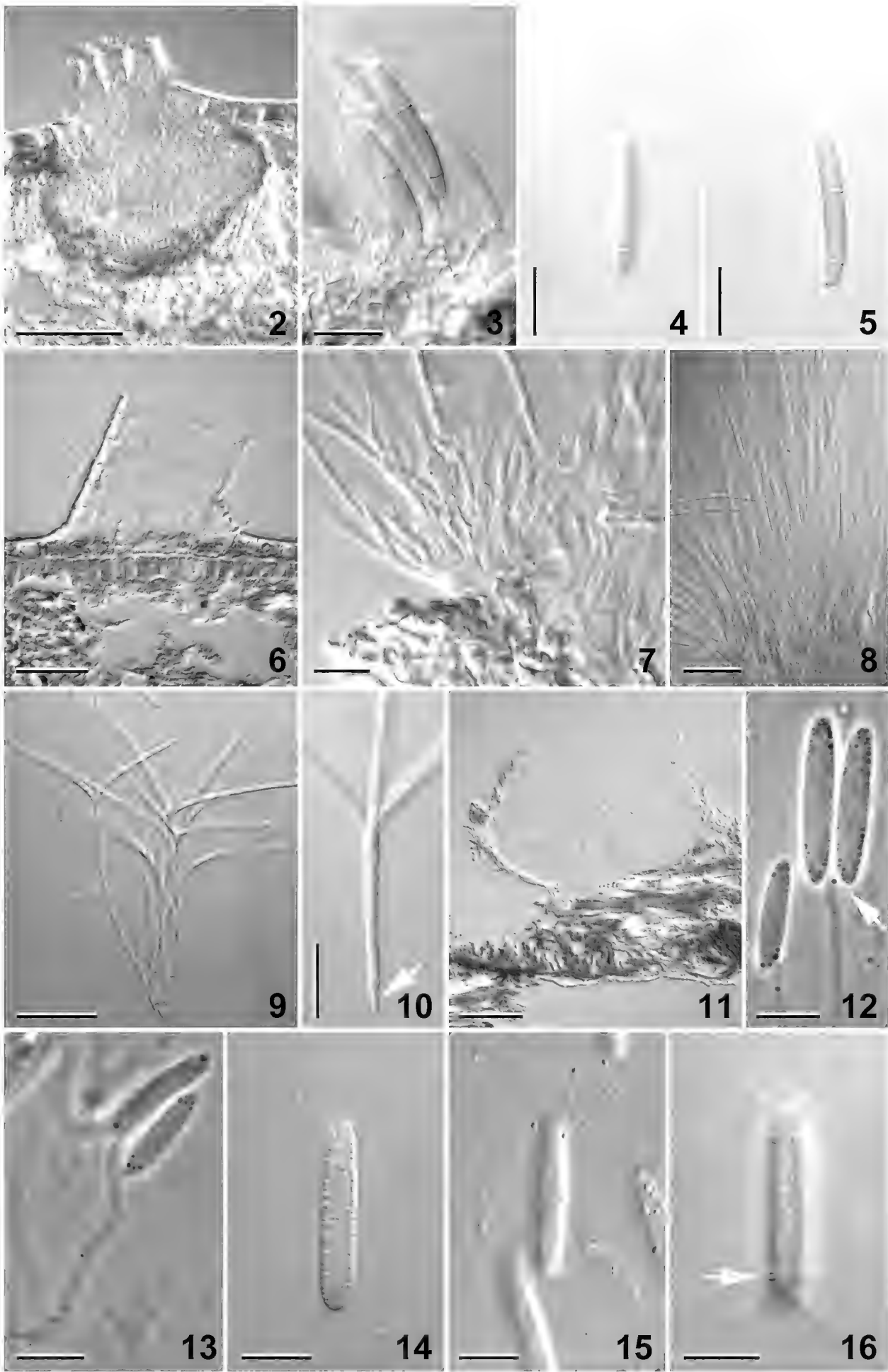
Conidiomata pycnidioidea. Conidiophorae ad cellulas conidiogenas reductae. Cellulae conidiogenae holoblasticae, discretae. Conidia versicoloria, cylindrica vel subcylindrica, ter septata, in septo non constricta (19–)21–24(–25.5) × 3–4 µm, cellula basali obconica, hyalina vel subcolorata cellulis, medianis 2, cylindricis, subcoloratis, cellula secunda e basi (8–)9–10(–11) µm longa, tertia (6–)7–8(–8.5) µm longa, cellula apicali conica, hyalina. Appendiculum apicale 3-ramosum, (10.5–)12–16(–19) µm longa, appendiculum basale unicum, excentricum, (3–)4–6(–6.5) µm longa.

TYPE—Collected 8 May 2008 in Mr. T. Abbott's garden (31° 02' 948'' S, 30° 10' 351'' E), Umtamvuna Nature Reserve, Port Edward, KwaZulu Natal, South Africa; in living leaves of *Maytenus abbottii* (Celastraceae) kept in moisture chamber; S.L. 1423(1), PREM 60359, **holotype**, ex-type cultures CBS 125525 = CMW 31067.

ETYMOLOGY: named after the visited Pondoland of the Maputaland-Pondoland-Albany biodiversity hotspot

EXPANDED DESCRIPTION — LEAF SPOTS not present, internal, asymptomatic infection. CONIDIOMATA immersed, sub-epidermis, stromatic, pycnidoid, sub-globose or ellipsoidal, 194–226 × 199–266 µm, ostiolate, unilocular, often convoluted. CONIDIOMATAL WALL 23.0–35.5 µm thick, composed of 3–6 layers of thick-walled, brown cells becoming compressed towards the outside, the outermost layer occasionally intermingled with host cells, inner 1–2 layers composed of thin-walled, sub-hyaline to hyaline cells, 4.0–8.5 µm thick. CONIDIOPHORES arising from the lower half of the conidioma, reduced to conidiogenous cells. CONIDIOGENOUS CELLS holoblastic, discrete, ampulliform to lageniform or cylindrical, hyaline, (3.5–)4–7(–7.5) µm long. CONIDIA versicolored, cylindrical or sub-cylindrical, straight or slightly curved, 3-septate, with no constrictions at septum, with basal and apical appendages, (19–)21–24(–25.5) × 3–4 µm (av. 22.3 × 3.5 µm), length/width ratio 6.4:1; basal cell obconic with a truncate base, hyaline or slightly pigmented, (2–)3(–4) µm

FIGS. 2–16. Microscopic images of fungi. FIGS. 2–5. *Bartalinia pondoensis* (holotype, PREM 60359). 2. Vertical section of conidioma. 3. Young conidia attached to conidiogenous cells. 4. Conidium with an apical appendage with 3 branches and an excentric basal appendage. 5. Versicolored conidium (BF). Scale bars: FIG. 2 = 100 µm; 3–5 = 10 µm. FIGS. 6–10. *Crucellisporium umtamvunae* (holotype, PREM 60360). 6. Vertical section of conidioma. 7, 9. Conidiogenous cells and developing conidia. 8. Sterile hyphae from the margin of conidioma. 10. Conidium with skewed, attenuated base (arrow). Scale bars: FIG. 6 = 50 µm; 7–9 = 20 µm; 10 = 10 µm. FIGS. 11–16. *Chaetospermum camelliae* 11. Vertical section of conidioma. 12, 13. Young conidia attached to conidiogenous cell in pair (PhC). 14. Conidium filled with minute granules. 15. Conidium with 4 cellular appendages at each end. 16. Conidium showing sub-polar appendages (arrow). Scale bars: FIG. 11 = 100 µm; 12–16 = 10 µm.



long; 2 median cells, cylindrical, thick-walled, slightly pigmented, (15–)16–18 (–19) μm long (the second cell from the base (8–)9–10(–11) μm long, the third cell from the base (6–)7–8(–8.5) μm long); apical cell conic, hyaline, 2–3 μm long, with a short tube (< 1 μm long) at the tip where branched appendages are attached; apical appendage with 3 branches, attenuated toward the tip, flexuous, (10.5–)12–16(–19) μm long; basal appendage single, filiform, excentric, (3–)4–6(–6.5) μm long. COLONIES reaching 58.7 mm in diam after 8 d, sterile, circular with entire margin, flat, with hairy strings of hyphae towards the center, Grey Olivaceous, becoming paler and submerged towards the margin.

COMMENTS — The genus was reviewed by Nag Raj (1993), who studied the then-known 20 species. Six species were accepted in his treatment, four were in question due to a paucity of specimens and sufficient information, three species were transferred to other genera, and two remained unexamined. Since then, four new species have been introduced. The most recent study on the taxonomy of *Bartalinia* Tassi is by Andrianova & Minter (2007). These authors provided a key to ten species including the six of those accepted by Nag Raj (1993), three species introduced since the review of Nag Raj (1993), and a new species, which they described as part of the study.

Bartalinia accommodates species having conidia with either three or four septa. Four species are known to have 3-septate conidia similar to *B. pondoensis*, namely *B. bischoffiae*, *B. tamarindi*, *B. bella*, and *B. bombacicola*. *Bartalinia bischoffiae* produces conidioma in pure culture and has conidia in vitro about the same size as *B. pondoensis* with, however, a conidia length/width ratio of 6:1; *B. tamarindi* has a 5.7:1 conidia length/width ratio; *B. pondoensis* is similar to *B. bella* (21–26 \times 3.5–5 μm) in conidial dimensions but is distinguished in having no constriction at the conidial septa and the second cell from the base longer than the third cell; *B. bombacicola* has shorter conidia (11–18 \times 3–5 μm) and longer apical appendage branches (18–32 μm) (Nag Raj 1993).

The Blastn search results of the DNA sequence data of *B. pondoensis* (GenBank GU291796) showed a 99% similarity to *B. laurina* (GenBank AF405302) and a 98 or 96% similarity to two isolates of *B. robillardoides* (GenBank AF405301, EU552102, respectively). These are the only *Bartalinia* spp. represented in Genbank with ITS sequences (Jeewon et al. 2002, Marincowitz et al. 2008). *Bartalinia laurina* has typical 4-septate conidia and occasionally 3-septate ones. Its conidia length/width ratio is 7.4:1 (Nag Raj 1993).

Chaetospermum camelliae Agnihothr., Mycopathologia 16: 115 (1962). FIGS. 11–16

EXPANDED DESCRIPTION — LEAF SPOTS not present, internal, asymptomatic infection. CONIDIOMATA gregarious, pycnidoid, becoming superficial with base immersed in the substratum, gelatinous when moistened, 230–608 \times

316–750 μm , mode opening undetermined. CONIDIOMATAL WALL consisting of a few to many layers of hyaline cells, 18–40 μm thick, textura intricata and gelatinous at the upper 2/3 of the conidioma, pseudoparenchymatous at the base, 14–25 μm thick, consisting of 6–8 hyaline, thick-walled, compressed cells. CONIDIOPHORES arising from the lower half of the conidioma, loosely aggregated, sparingly branched and septate at the base. CONIDIOGENOUS CELLS holoblastic, discrete, cylindrical, 24–47 \times 2–2.5 μm , bearing an apical cluster of 2 conidia. CONIDIA hyaline, narrowly ellipsoidal to cylindrical, (25–)26–29 (–32) \times (4–)4.5–5 μm (av. 27.6 \times 4.8 μm), with sub-polar appendages at both ends, minute granules abundant; appendages mostly 4 at each end, tubular, unbranched, flexuous, 16–22 μm long, 1–2 μm wide at the base becoming attenuated to the tip.

SPECIMEN EXAMINED— SOUTH AFRICA. KwaZULU-NATAL: Port Edward, UMTAMVUNA NATURE RESERVE (Fish Eagle trail)—in living leaves of *Syzygium cordatum* (Myrtaceae) kept in moisture chamber, 7 May 2008, S.L. 1424(1), PREM 60361.

HOSTS — *Adiantum tenerum*, *Archontophoenix alexandrae*, *Coffea canephora*, *Cupressus macrocarpa*, *Ficus pleurocarpa*, *Hevea* sp., *Licuala longicalycata*, *Northia fasciculata*, *Phragmites australis*, *Salix* sp., *Sorbus alnifolia*, *Syzygium cordatum*, *Thea sinensis*, *Trachycarpus fortunei*, *Typha angustifolia*.

GEOGRAPHICAL DISTRIBUTION — AFRICA: Kenya, South Africa; ASIA: China, India, Japan, Republic of Korea, Malaysia, Taiwan, Thailand; AUSTRALASIA: Australia; EUROPE: UK; NORTH AMERICA: Mexico, USA; SOUTH AMERICA: Bermuda, Cuba, French Guiana, Venezuela.

COMMENTS — Nine species and one variety are known for *Chaetospermum*. Since the most recent treatment by Nag Raj (1993), no new species have been described. He accepted four species, reduced two to synonymy, regarded two as dubious, and did not examine one. *Chaetospermum camelliae* has been reported on various host plants in many parts of the world. The same species was recorded earlier on the litter of *Syzygium cordatum* (Crous 1993) but was misidentified as *C. chaetosporum* (Vadim Mel'nik, pers. comm.).

***Crucellisporium umtamvunae* Marinc., Gryzenh. & M.J. Wingf., sp. nov.**

MYCOBANK 515556

FIGS. 6–10

Conidiomata sporodochiiformia. Hyphae steriles adsunt. Conidiophorae basi ramosae, non vel semel septatae. Cellulae conidiogenae holoblasticae integratae, cylindricae. Conidia hyalina, ex axe principali ramisque facta, axe principali tubulari, (19–)22.5–29(–31) \times (1–)1.5–2 μm , non vel ad bis septato, ramis plerumque 3, apicem versus attenuatis (35–)41–51(–52) \times 1 μm , non vel semel septatis.

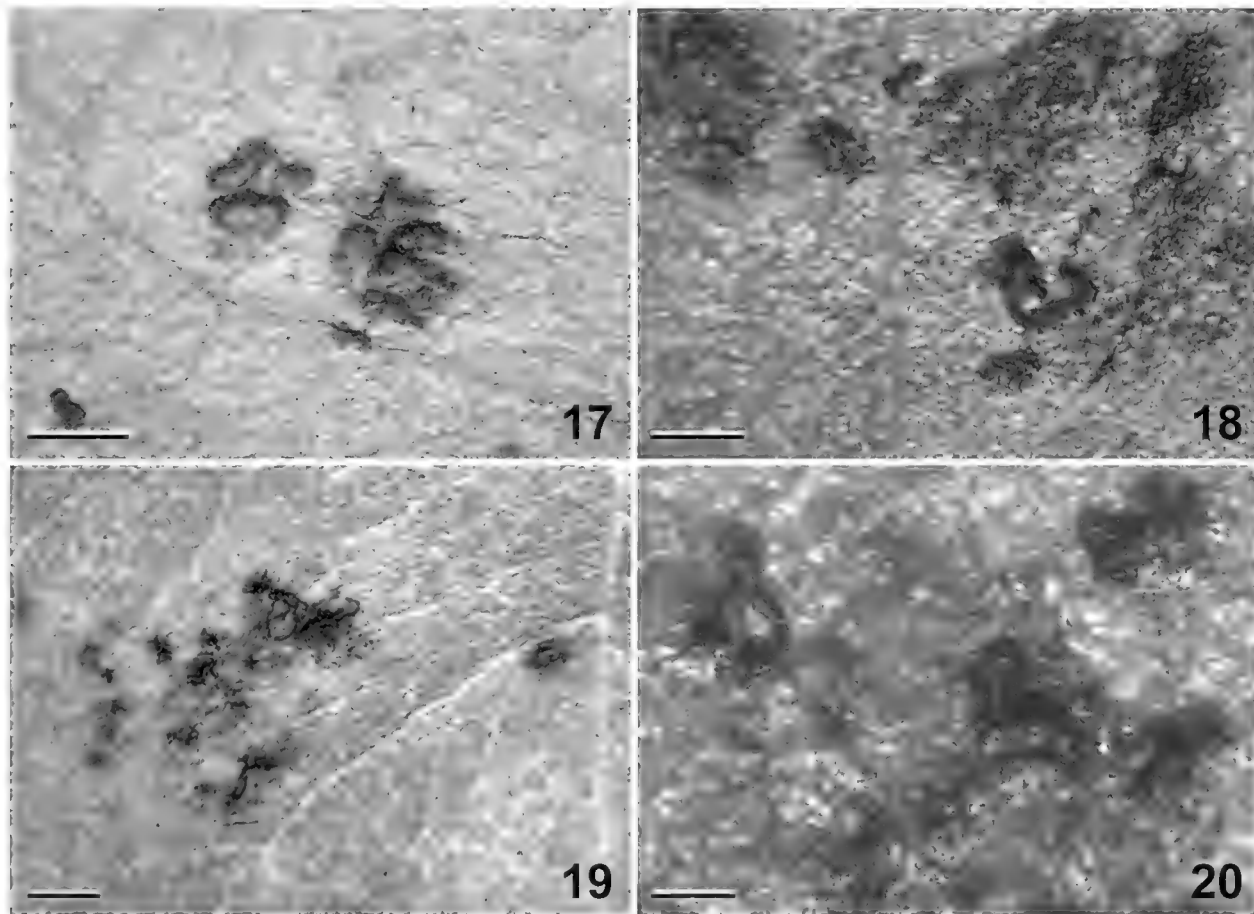
TYPE—Collected 7 May 2008, Fish Eagle trail, Umtamvuna Nature Reserve, Port Edward, KwaZulu Natal, South Africa; in living leaves of *Nectaropetalum zuluense* (Erythroxylaceae) kept in moisture chamber; S.L. 1428(1), PREM 60360, **holotype**, ex-type culture CMW 31068.

ETYMOLOGY: named after the Umtamvuna Nature Reserve

EXPANDED DESCRIPTION — LEAF SPOTS not present, internal, asymptomatic infection. CONIDIOMATA scattered, acervular, 18–23 μm high, 38–122 μm wide at the base, superficial with a base immersed in the epidermis of substratum, ruptured by lifting up THE cuticle. CONIDIOMATAL WALL at the base pseudoparenchymatous, textura epidermoidea, composed of 3–5 layers of hyaline, thick-walled cells, at the side textura intricata, 8–16 μm wide, composed of 5–7 layers of slightly pigmented, longitudinally elongated cells, with sterile hyphae formed around the margin, individual, hyaline, straight, 2–3 μm thick, length varies with regular septation in 8–19 μm intervals. CONIDIOPHORES branched at the base, 0–1-septate, 10–35 μm long, restricted to the base of the conidioma. CONIDIOGENOUS CELLS holoblastic, integrated, cylindrical, hyaline, $7.5\text{--}20.5 \times 1\text{--}2 \mu\text{m}$. CONIDIA hyaline, consisting of main axis and branches; main axis tubular with a base becoming skewed, attenuated, (19–)22.5–29(–31) \times (1–)1.5–2 μm (av. $25.5 \times 1.6 \mu\text{m}$), 0–2-septate, becoming slightly thicker at the point of branching; branches (or arms) mostly 3, attenuated to the tip, (35–)41–51(–52) \times 1 μm (av. $45.9 \times 1.2 \mu\text{m}$), 0–1-septate. COLONIES reaching 16.3 mm in diam after 14 d, flat with aerial hyphae bundles, denser near the centre, circular with entire margin, sterile, above hyphae dense, with slight tint of Pale Cinnamon Pink near the center, reverse Pale Cinnamon Pink in the inner half and Cartridge Buff in the outer half.

COMMENTS — Two species, *C. selaginellae* and *C. africanum*, are represented in the genus *Crucellisporium* M.L. Farr. They can be distinguished from *C. umtamvunae* by conidial characters: *Crucellisporium selaginellae* has no basal appendage and both the main axis and branches of the conidia are aseptate while *C. africanum* has shorter conidial branches (14–32 μm long) and basal appendages (0.5–3 μm long) (Nag Raj 1993).

The Blastn search results of the DNA sequence data of *C. umtamvunae* (GenBank GU291797) showed an 89% similarity to *Hyphodiscus hymeniophilus* (*Helotiales*, *Hyaloscyphaceae*; Untereiner et al. 2002; GenBank DQ227258), an 89% similarity to *Cryptosporiopsis ericae* (*Helotiales*, mitosporic *Dermateaceae*; Sigler et al. 2005; GenBank AY540126, AY540126) and an 89% similarity to *Hyalodendriella betulae* (*Helotiales* inc. sed., Crous et al. 2007; GenBank EU040232). A blast search on the AFTOL database (<http://aftol.biology.duke.edu/pub/blast/> blastUpload) showed that *Lachnum bicolor* (177.3005.2; *Helotiales*, *Hyaloscyphaceae*), *L. virgineum* (49.2770.2), *Bisporella citrina* (1301.5518.2; *Helotiales*, *Helotiaceae*), and *Neofabraea malicorticis* (149.3033.2; *Helotiales*, *Dermateaceae*) are closely related (Wang et al. 2006). It is thus clear that *C. umtamvunae* resides in the *Helotiales*, but its family position remains uncertain.

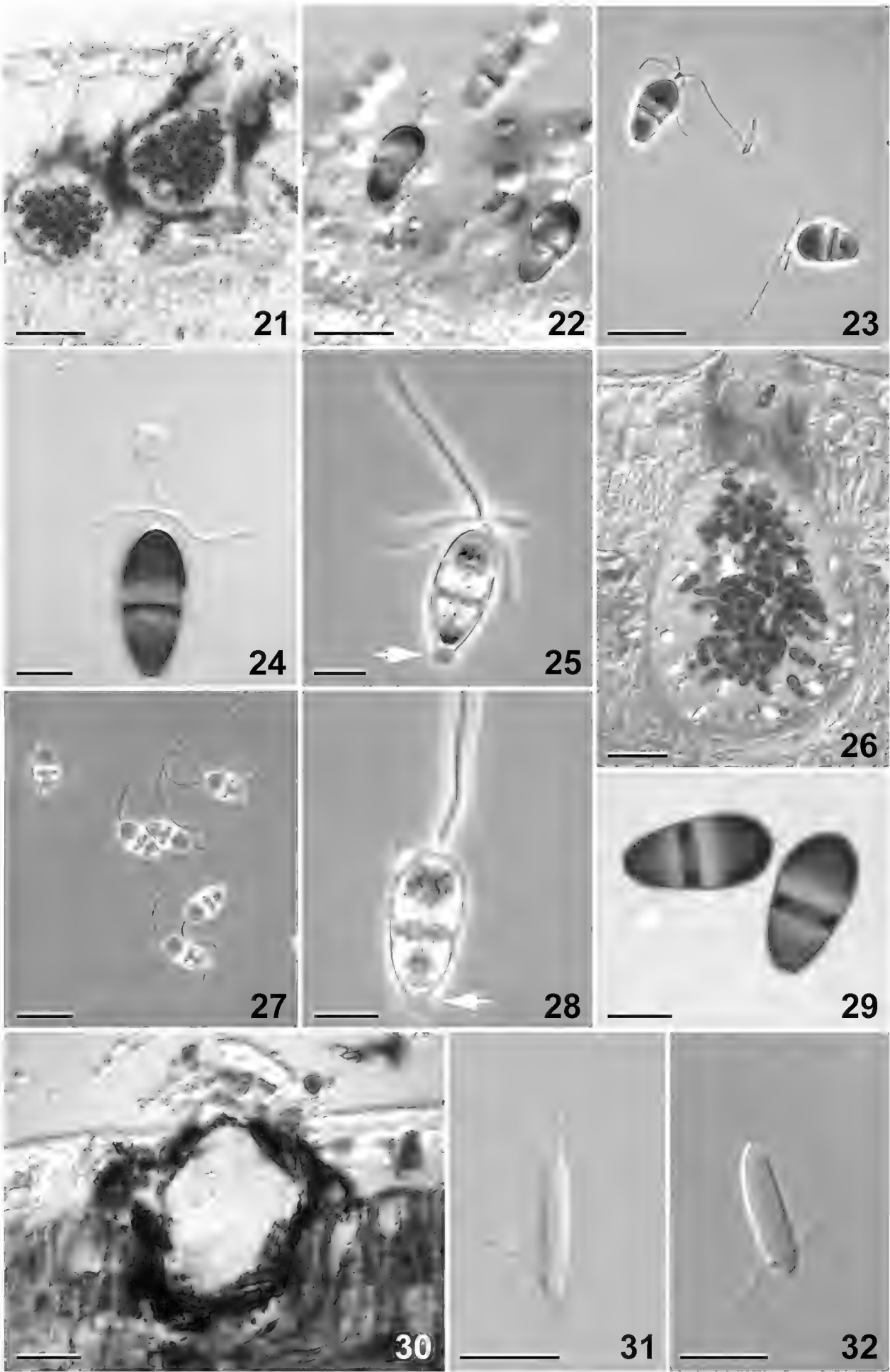


FIGS. 17–20. Symptoms of *Mycohypallage* on living leaves. FIGS. 17, 18. *M. congesta* in purple spots consisting of a few bumps and exuding dark spores in cirrhus. Scale bars: FIG. 17 = 1 mm; 18 = 500 μ m. FIGS. 19, 20. *M. margaretiae* (holotype, PREM 60364) with exuding dark spores in cirrhi. Scale bars: FIG. 19 = 1 mm; 20 = 250 μ m.

Mycohypallage congesta (Berk. & Broome) B. Sutton, Mycological Papers 88: 5 (1963).

FIGS. 17, 18, 21–25

EXPANDED DESCRIPTION — LEAF SPOTS on the upper side of the leaf, in groups, of dark purple spots, irregularly shaped in 1.0–1.5 \times 1.0–1.4 mm, each consisting of 3–many bumps of 250–820 μ m wide, often with exuding dark spores in cirrhi or with scattered dark spores like granules. CONIDIOMATA gregarious, immersed with an ostiole reaching the surface of substratum, sub-epidermis, pycnidoid, at times convoluted, sub-globose or ellipsoidal, 280–320 \times 216–320 μ m, ostiole with periphyses brown, septate, 5–6.5 μ m thick. CONIDIOMATAL WALL 16–24.5 μ m thick, consisting of several layers of highly compressed, hyaline or brown, thick-walled cells, becoming brown around the ostiole. STERILE HYPHAE cylindrical, 1–3-septate, brown, arising from all around the inside of conidioma among conidiophores, 20–45 \times 4–5 μ m. CONIDIOPHORES reduced to conidiogenous cells. CONIDIOGENOUS CELLS holoblastic, discrete, cylindrical, 6–14 \times 3–4.5 μ m. CONIDIA brown, with wide, paler median band, clavate with an obtuse apex and a truncate base, (21–)22–25(–26) \times (9–)10–11



μm (av. $23.4 \times 10.2 \mu\text{m}$), 1-septate, with apical and basal appendages; apical appendage tubular, unbranched for a short length from the base, $1-2(-2.5) \mu\text{m}$ (av. $1.5 \mu\text{m}$) and then branching irregularly; branches mostly 4–5, more or less attenuated, flexuous, $(17.5-)-26-41(-45) \mu\text{m}$ long (av. $33.5 \mu\text{m}$); basal appendage often present, visible in water, gelatinous, doliiform, $2-4 \times 3-4.5 \mu\text{m}$.

SPECIMEN EXAMINED— SOUTH AFRICA. KwaZULU-NATAL: Port Edward, UMTAMVUNA NATURE RESERVE (Porcupine trail)—in living leaves of *Syzygium cordatum*, 8 May 2008, S.L. 1412A, PREM 60362. RED DESERT—in living leaves of *Syzygium cordatum*, 7 May 2008, S.L. 1401C, PREM 60363.

HOSTS — *Eugenia heyneana*, *Syzygium cordatum*, *S. cumini*, *S. guineense*, *S. jambolanum*, *Syzygium* sp.

GEOGRAPHICAL DISTRIBUTION — AFRICA: Uganda, South Africa, Zambia; ASIA: India, Sri-Lanka.

TELEOMORPH — *Deshpandiella jambolana* (T.S. Ramakr., Sriniv. & Sundaram) Kamat & Ullasa, in Ullasa & Rao, Bull. Torrey Bot. Club 100: 42 (1973).

COMMENTS — Two species were described in *Mycohypallage*: *M. congesta* and *M. northeae* Melnik. However, the second of these was reduced to synonymy with *Robillarda sessilis* (Sacc.) Sacc. (Nag Raj 1993), so that the genus is currently monotypic. *Mycohypallage congesta* was reported on living leaves of *Syzygium* and *Eugenia* from Africa and Asia (Nag Raj 1993, Farr & Rossman 2009). Several attempts to grow this fungus in culture failed. Gelatinous basal appendages (FIG. 25) were observed in the specimen recorded here and these have not been seen previously.

***Mycohypallage margaretae* Marinc., Gryzenh. & M.J. Wingf., sp. nov.**

MYCOBANK 515557

FIGS. 19, 20, 26–29

Conidia immersa pycnidioidea. Conidiophorae ad cellulas conidiogenas reductae. Cellulae conidiogenae holoblasticae, discretiae. Conidia brunnea cum vitta lata pallidiore, clavata apice obtuso basi truncato, $(21-)-22-25(-26) \times 9-11(-12) \mu\text{m}$, semel septata, cum appendiculo apicali et appendiculis basalibus; appendiculum apicale tubulare, non ramosum; appendiculum basale saepe adest, in aquo manifestum, gelatinosum doliiforme.

FIGS. 21–32. Microscopic images of fungi. FIGS. 21–25. *Mycohypallage congesta*. 21. Vertical section of conidioma. 22. Young conidia attached to conidiogenous cells. 23. Conidia with an apical appendage of 4–5 branches (PhC). 24. Conidium body with a wide, paler median band. 25. Conidium with a gelatinous basal appendage (PhC, arrow). Scale bars: FIG. 21 = $100 \mu\text{m}$; 22, 23, = $20 \mu\text{m}$; 24, 25, = $10 \mu\text{m}$. FIGS. 26–29. *M. margaretae* (holotype, PREM 60364). 26. Vertical section of conidioma. 27. Conidia with an unbranched appendage (PhC). 28. Conidium with a gelatinous basal appendage (PhC, arrow). 29. Conidium body with a wide, paler median band (BF). Scale bars: FIG. 26 = $50 \mu\text{m}$; 27 = $20 \mu\text{m}$; 28, 29 = $10 \mu\text{m}$. FIGS. 30–32. *Mycotribulus mirabilis*. 30. Vertical section of conidioma. 31, 32. Conidium with appendages at both ends. Scale bars: FIG. 30 = $50 \mu\text{m}$; 31, 32 = $10 \mu\text{m}$.

TYPE—Porcupine trail, Umtamvuna Nature Reserve, Port Edward, KwaZulu-Natal, South Africa; in living leaves of *Syzygium cordatum*, 8 May 2008; S.L. 1406A, PREM 60364, **holotype**.

ETYMOLOGY: named for Mrs. Margaret (Maggi) Abbott acknowledging her contribution to the knowledge of the flora of Pondoland

EXPANDED DESCRIPTION — LEAF SPOTS on the upper side of the leaf, discoloured lesions, roughly ellipsoidal, $2.5\text{--}5.0 \times 2.0\text{--}4.0$ mm, consisting of scattered dark bumps, often with exuded dark spores in cirrhi or with scattered dark spores like granules. CONIDIOMATA immersed with an ostiole reaching the surface of substratum, sub-epidermis, gregarious, pycnidoid, unilocular, often convoluted, sub-globose to ellipsoidal, $275\text{--}365.5 \times 162\text{--}193$ μm , ostiole with periphyses sub-hyaline to brown, septate, $3\text{--}5$ μm thick. CONIDIOMATAL WALL $10\text{--}21$ μm thick, consisting of several layers of highly compressed, sub-hyaline to pale brown, thick-walled cells, brown around the ostiole. CONIDIOPHORES not observed, probably simple or reduced to conidiogenous cells, arising from all around the conidioma. CONIDIOGENOUS CELLS holoblastic, discrete, cylindrical. CONIDIA brown, with a wide, paler median band, clavate with an obtuse apex and a truncate base, $(21\text{--})22\text{--}25(\text{--}26) \times 9\text{--}11(\text{--}12)$ μm (av. 23.4×10.4 μm), 1-septate, with apical appendage and basal appendages; apical appendage tubular, unbranched, more or less attenuated, flexuous, $(55.5\text{--})77.5\text{--}93(\text{--}95)$ μm (av. 85.3 μm); basal appendage often present, visible in water, gelatinous, doliiform, $1\text{--}1.5 \times 2\text{--}3$ μm .

ADDITIONAL SPECIMENS EXAMINED— SOUTH AFRICA. KWAZULU-NATAL: Port Edward UMTAMVUNA NATURE RESERVE (Mr. T. Abbott's garden, $31^{\circ} 02' 948''$ S, $30^{\circ} 10' 351''$ E)—in living leaves of *Syzygium* sp. "Van Wyk", 8 May 2008, S.L. 1417C, PREM 60366. RED DESERT—in living leaves of *Syzygium cordatum*, 7 May 2008, S.L. 1400A, PREM 60365.

COMMENTS — The second species of *Mycohypallage*, *M. margaretae*, can be distinguished from *M. congesta* by its apical appendage. The former has a single, long appendage whereas *M. congesta* has short, branched appendages. Among the isolates, the appendage of PREM 60365 [$(73\text{--})86\text{--}100.5(\text{--}114)$ μm long (av. 93.3 μm)] was slightly longer than that of the holotype.

Mycotribulus mirabilis Nag Raj & W.B. Kendr., Canadian Journal of Botany 48(12): 2219 (1970). FIGS. 30–32

EXPANDED DESCRIPTION — LEAF SPOTS not present, internal, asymptomatic infection. CONIDIOMATA immersed, sub-epidermis, pycnidoid, $163\text{--}178.5 \times 152\text{--}168$ μm , ostiole absent, dehiscence by irregular rupture on apical wall that reach surface of the substratum. CONIDIOMATAL WALL composed of 3–5 layers of brown, thick-walled, moderately compressed cells, $25.5\text{--}29$ μm thick. CONIDIOPHORES and CONIDIOGENOUS CELLS not observed, probably due

to senescent specimen. CONIDIA hyaline, fusiform with an acute apex and a tapered and truncated base, $(13-14-17(-18) \times 3-4 \mu\text{m}$ (av. $15.5 \times 3.6 \mu\text{m}$), aseptate, bearing appendages at both ends; apical appendage, polar, filiform, straight or curved, $(6-7-9(-10) \mu\text{m}$ long (av. $7.9 \mu\text{m}$); basal appendage, mostly 3, inserted laterally slightly above the truncate base, unbranched, straight or curved, $8-10(-11) \mu\text{m}$ (av. $9.0 \mu\text{m}$).

SPECIMEN EXAMINED— SOUTH AFRICA. KwaZULU-NATAL: Port Edward, UMTAMVUNA NATURE RESERVE (Porcupine trail)—in living leaves of *Apodytes abbotii* (*Icacinaceae*), 8 May 2008, S.L. 1407D, PREM 60367.

HOSTS — *Apodytes abbotii*, *Eucalyptus camaldulensis*, *E. grandis*, *E. robusta*, *E. saligna*, *E. tereticornis*, *Eucalyptus* sp., *Mangifera indica*, *Syzygium cordatum*.

GEOGRAPHICAL DISTRIBUTION — AFRICA: South Africa; ASIA: India, Thailand; NORTH AMERICA: West Indies; PACIFIC: Hawaii; SOUTH AMERICA: Brazil, Cuba.

COMMENTS — This monotypic genus was previously reported on *Syzygium cordatum* in South Africa (Crous 1993).

Acknowledgments

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Literature cited

- Abbott A, Van Wyk AE. 2000. Checklist of the macrofungi, lichens, bryophytes and vascular plants of the Umtamvuna Nature Reserve, South Africa. *Lammergeyer* 46: 1–69.
- Andrianova TV, Minter DW. 2007. New species of *Bartalinia* and *Septoriella* from the Altai Mountains (Russia). *Mycotaxon* 101: 297–313.
- Crous PW. 1993. New and interesting records of South African fungi. XIII. Follicolous microfungi. *South African Journal of Botany* 59: 602–610.
- Crous P.W., Braun U, Schubert K, Groenewald JZ. 2007. Delimiting *Cladosporium* from morphologically similar genera. *Studies in Mycology* 58: 33–56.
- Farr DF, Rossman AY. 2009. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. Retrieved April 17, 2009, <http://nt.ars-grin.gov/fungaldatabases/>
- Gryzenhout M, Myburg H, Van der Merwe NA, Wingfield BD, Wingfield MJ. 2004. *Chrysoporthe*, a new genus to accommodate *Cryphonectria cubensis*. *Studies in Mycology* 50: 119–142.
- Hoog GS de, Gerrits van den Ende AHG. 1998. Molecular diagnostics of clinical strains of filamentous Basidiomycetes. *Mycoses* 41: 183–189.
- Jeewon R, Liew ECY, Hyde KD. 2002. Phylogenetic relationships of *Pestalotiopsis* and allied genera inferred from ribosomal DNA sequences and morphological characters. *Molecular Phylogenetics and Evolution* 25: 378–392.

- Marincowitz S, Crous PW, Groenewald JZ, Wingfield MJ. 2008. Microfungi occurring on *Proteaceae* in the fynbos. CBS Biodiversity series 7: 1–166.
- Möller EM, Bahnweg G, Sandermann H, Geiger HH. 1992. A simple and efficient protocol for isolation of high molecular weight DNA from filamentous fungi, fruit bodies, and infected plant tissues. *Nucleic Acids Research* 20: 6115–6116.
- Nag Raj TR. 1993. Coelomycetous anamorphs with appendage-bearing conidia. Mycologue Publications: Waterloo, Canada. 1101 pp.
- Nag Raj TR, Kendrick B. 1978. Genera coelomycetarum. XV. *Belaina*, *Belainopsis* and *Crucellisporium*. *Canadian Journal of Botany* 56(6): 708–714.
- Rayner RW. 1970. A mycological colour chart. Commonwealth Mycological Institute and British Mycological Society: Kew, Surrey, UK. 34 pp.
- Rehner SA, Samuels GJ. 1994. Taxonomy and phylogeny of *Gliocladium* analysed from nuclear large subunit ribosomal DNA sequences. *Mycological Research* 98: 625–634.
- Sigler L, Allan T, Lim SR, Berch S, Berbee M. 2005. Two new *Cryptosporiopsis* species from roots of ericaceous hosts in western North America. *Studies in Mycology* 53: 53–62.
- Silander JA Jr. 2001. Temperate rainforests. In: *Encyclopedia of Biodiversity*, Vol. 5, Academic Press, San Diego, USA. 607–626 p.
- Steenkamp Y, Van Wyk AE, Victor JE, Hoare DB, Dold AP, Cowling RM, Smith GF. 2004. Maputaland-Pondoland-Albany. In: Mittermeier RA, Hoffmann M, Pilgrim JD, Brooks TB, Mittermeier GC, Lamoureux JL, Da Fonseca G (eds). *Hotspots revisited: Earth's biologically richest and most endangered ecoregions*. Cemex, Mexico City, Mexico. 392 pp.
- Sutton BC. 1980. The Coelomycetes: Fungi Imperfecti with Pycnidia, Acervuli and Stromata. Commonwealth Mycological Institute: Kew, Surrey, UK. 696 pp.
- Untereiner WA, Naveau FA, Bachewich J, Angus A. 2006. Evolutionary relationships of *Hyphodiscus hymeniophilus* (anamorph *Catenulifera rhodogena*) inferred from β -tubulin and nuclear ribosomal DNA sequences. *Canadian Journal Botany* 84: 243–253.
- Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology* 172: 4238–4246.
- Wang Z, Binder M, Schoch CL, Johnston PR, Spatafora JW, Hibbett DS. 2006. Evolution of helotialean fungi (Leotiomycetes, Pezizomycotina): A nuclear rDNA phylogeny. *Molecular Phylogenetics & Evolution* 41: 295–312.
- White TJ, Bruns T, Lee J, Taylor J. 1990. Amplification and direct sequencing, of fungal ribosomal RNA genes for phylogenetics. In: Innis MA, Gelfand, DH, Sninsky JJ, White TJ (eds), *PCR protocols: a guide to methods and applications*: 315–322. Academic Press, San Diego, California, USA.

New taxa in the genus *Lyophyllum* s.l. from La Palma (Canary Islands, Spain)

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Abstract — Four new taxa in the genus *Lyophyllum* (*L. brunneum*, *L. infidum*, *L. pseudoloricatum*, and *L. pseudoloricatum* f. *lactellum*), collected in La Palma (Canary Islands), are here described and taxonomically delimited based on morphological data. For each species detailed descriptions, microscopical drawings and plates are presented. Notes on closely related species are also added.

Key words — *Basidiomycota*, *Agaricomycetes*, *Lyophyllaceae*, taxonomy, biodiversity

Introduction

Among the numerous collections of *Lyophyllaceae* made in La Palma (Canary Islands) during a long-term survey of *Agaricales*, several interesting taxa were found, some of which were well characterised both macro- and micromorphologically and deserving of special attention and a formal description.

The present paper deals with four of them, all belonging to *Lyophyllum* P. Karst. emend. Kühner, viz., *L. brunneum* sp. nov., *L. infidum* sp. nov. and *L. pseudoloricatum* sp. nov., the last one being collected also in a white form, which is also proposed as new. All the agarics presented in this paper were collected in mixed forests with *Pinus radiata* D. Don and/or *Pinus canariensis* C. Sm., at an altitude of 1300–1400 m a.s.l.

Materials and methods

The macromorphological descriptions follow the detailed field notes taken for each collection on fresh material by the first author. The micromorphological descriptions are

*corresponding author

based both upon study of fresh and herbarium material. Dried material was revived in KOH 2% and stained in Congo red and Phloxine B. Cotton Blue was utilized to highlight the siderophilous granulation in the basidia (Baroni 1981). Spore measurements are based on means of 30 spores. The width of basidia was measured at the thickest part, and the length was measured from the apex (sterigmata excluded) to the basal septum. We followed the taxonomic concept of Bon (1999) for the *Lyophyllaceae* because a natural (molecular based) classification has not yet been proposed for this group, despite the important preliminary study by Hofstetter et al. (2002). Abbreviations of author names follow Kirk & Ansell (2003). Colour notations in the macroscopic descriptions are from Séguy, Code Universel des Couleurs (1936), cited here as (Se). Herbarium abbreviations are according to Holmgren & Holmgren (1998). All examined material (type-collections included) is housed at TO (Herbarium generale del Dipartimento di Biologia Vegetale, Università degli Studi di Torino, Italy). Latin descriptions of all new taxa are deposited in MycoBank (<http://www.mycobank.org>).

Taxonomy

Lyophyllum brunneum Dähncke, Contu & Vizzini, **sp. nov.**

FIGS. 1a, 2a–c

MYCOBANK MB515106

Pileus 3–7.5 cm *latus*, *carnosus*, *convexus*, *brunneus*, *radialiter fibrillosus*. *Lamellae subconfertae*, *subliberae*, *cremeae deinde roseo-brunneae*. *Stipes* 6–9 × 1.5–2.5 cm, *solidus*, *clavatus et haud bulbosus*, *albus*, *politus*. *Caro firma*, *alba*, *immutabilis*. *Odor saporque debiles*. *Sporae* 6–7(–7.5) × 4.5–5(–5.5) µm, *late ellipsoideae vel ellipsoideae*, *obtusae*, *leves*. *Basidia* 30–38 × 7–9 µm, *tetraspora*. *Cellulae marginales* 20–45 × 3.5–5 µm, *diverticulatae vel nodulosae*, *abundantes*. *Pilei cutis ex hyphis iacentibus*, *radialibus*, 2–7 µm *latis efformata*. *Fibulae numerosae*.

HOLOTYPE: *Hispania, Insulae Canariae, in insula La Palma dicta, ad locum dictum El Pilar, 25.XI.2007, leg. R.M. Dähncke (TO HG1725).*

ETYMOLOGY. The specific epithet, derived from the Latin adjective *brunneus*, -a, -um, refers to the brown-pigmented pileus.

PILEUS 3–7.5 cm wide, fleshy, broadly convex or convex-paraboloid with an inrolled margin, not expanding, without umbo, dry, glabrous even if radially fibrillose, fuscous-brown (Se 131-134) then brown (Se 691-692) with a darker center (Se 126), not or scarcely hygrophanous. **LAMELLAE** close, horizontal, almost free, moderately thin to thin, at first cream (Se 199, 200) then pinkish to pinkish-brown (Se 202-204), brownish (691, 703) in old basidiomata, not staining when bruised. **STIPE** 6–9 × 1.5–2.5 cm, solid, clavate, often with an inflated basis, lacking a bulb, polished, white, stuffed with a thick white pith. **CONTEXT** thick in the disk but progressively thinner towards the pileus margin, white, unchanging; smell and taste none.

SPORES 6–7(–7.5) × 4.5–5(–5.5) µm, on average 6.8 × 4.7 µm, hyaline, cyanophilous, carminophilous, broadly ellipsoid to ellipsoid, smooth, with a single, central, oil-drop, apex obtuse. **BASIDIA** 30–38 × 7–9 µm, four-spored, clavate, with basal clamp-connection; **SUBHYMENIUM** ramose, made up of

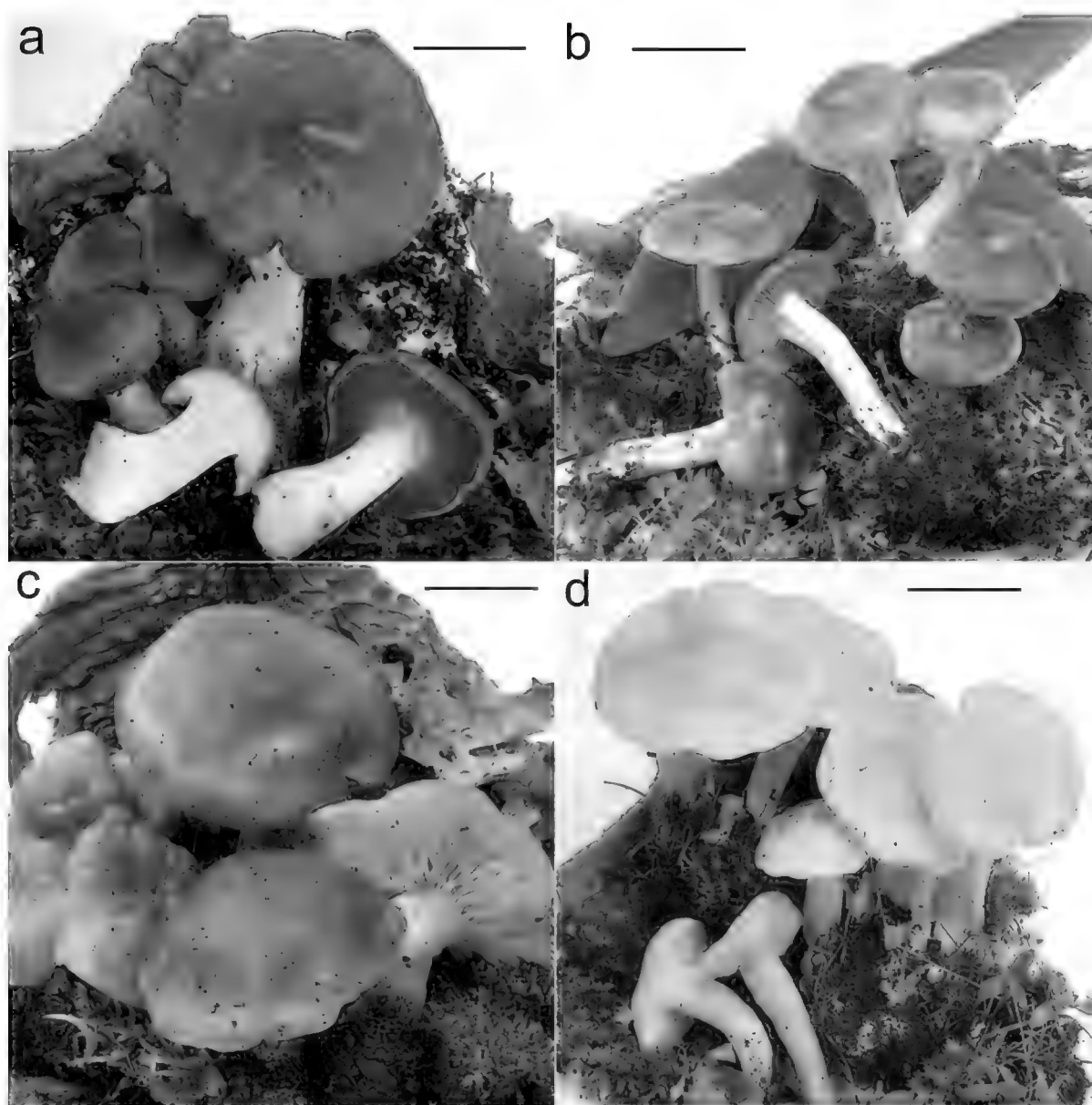


FIGURE 1. Basidiomes. a. *Lyophyllum brunneum*. b. *L. infidum*. c. *L. pseudoloricatum*. d. *L. pseudoloricatum* f. *lactellum*. Scale bars = 2 cm

thin hyphae. HYMENOPHORAL TRAMA regular, made up of thin, hyaline hyphae. MARGINAL CELLS $20\text{--}45 \times 3.5\text{--}5 \mu\text{m}$, abundant, diverticulate-nodulose, thin-walled, hyaline, sometimes uni- to pluriseptate. PILEIPELLIS a compact xerocutis of repent, smooth, cylindro-clavate hyphae, $2\text{--}7 \mu\text{m}$ wide, with dominant parietal pigment which is also vacuolar in some elements. STIPITPELLIS a cutis of elongate hyphae. CLAMP-CONNECTIONS present at all septa. THROMBOPLEROUS HYPHAE not seen.

HABITAT. Caespitose in mixed woods with *Pinus canariensis* and *Pinus radiata*. Autumn.

COMMENTS. *Lyophyllum brunneum* is unique in the section *Aggregata* due to the fleshy stature, the brown tinges in the pileus, the abundant nodulose marginal cells, and broadly ellipsoid spores. *Lyophyllum subglobisporum* Consiglio & Contu 2001, also collected by the first author in La Palma, differs

in having smaller, less elongate spores and in lacking marginal cells (Consiglio & Contu 2002); *L. pseudoloricatum* (see below) has a cartilaginous context, bigger spores, cellular subhymenium, and lacks marginal cells. The European key to *Lyophyllum* section *Aggregata* (Bon 1999) cites some French records of an unpublished entity close to *L. lorricatum* (Fr.) Kühner ex Kalamees 1994 but showing “cheilocystides important mais variables, de lagéniform à +/- lobées-diverticulées.” Globose spores and a more hygrophanous pileus differentiate this fungus from *L. brunneum*.

***Lyophyllum infidum* Dähncke, Contu & Vizzini, sp. nov.**

FIGS. 1b, 2d–e

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Pileus 2–2.5 cm *latus*, *parce carnosus*, *convexus*, *ad medium umbonatus*, *pallide griseo-brunneus*, *pruina alba obtecto*. *Lamellae subconfertae*, *adnatae*, *griseo-brunneae*. *Stipes* 3–4 × 0.3–0.6 cm, *fragilis*, *cylindricus*, *pileo pallidior*, *fibrillosus*. *Caro parce conspicua*, *brunnea*, *in siccis nigrescens*. *Odor saporque farinacei*. *Sporae* 5.2–6.7 × 3–4.5 μm, *late ellipsoideae vel ellipsoideae*, *obtusae*, *leves*. *Basidia* 25–30 × 7–8 μm, *tetraspora*. *Cellulae marginales nullae vel inconspicuae*. *Pilei cutis ex hyphis iacentibus*, *radialibus*, 2–7 μm *lat. efformata*. *Fibulae numerosae*.

HOLOTYPE: *Hispania, Insulae Canariae, in insula La Palma dicta, ad locum dictum Hoyo del Rehielo, 19.XI.2005, leg. R.M. Dähncke (TO HG1726).*

ETYMOLOGY. The specific epithet is derived from the Latin adjective *infidus*, -a, -um (= not faithful) and therefore meaning a deceptive, not obvious, species.

PILEUS 2–2.5 cm wide, not very fleshy, subcartilaginous, broadly convex or convex-paraboloid, then convex but never expanding, with a small and rounded central umbo, dry, white-pruinose, light greyish-brown (Se 427) with a darker center (Se 434), hygrophanous and fading with age. **LAMELLAE** close, adnate, moderately thin to thin, greyish-brown (Se 233–235), not staining when bruised but black in dried material. **STIPE** 3–4 × 0.3–0.6 cm, not solid, subequal, paler than pileus, surface appressed fibrillose. **CONTEXT** thin, brownish, apparently unchanging but black in dried material; smell and taste farinaceous.

SPORES 5.2–6.7 × 3–4.5 μm, on average 5.8 × 3.7 μm, hyaline, cyanophilous, carminophilous, broadly ellipsoid to ellipsoid with an obtuse apex, smooth, with several oil-drops, very slightly thick-walled. **BASIDIA** 25–30 × 7–8 μm, four-spored, clavate, with basal clamp-connection; **SUBHYMENIUM** made up of inflated, hyaline elements. **HYMENOPHORAL TRAMA** regular, made up of thin, hyaline hyphae. **MARGINAL CELLS** inconspicuous. **PILEIPELLIS** a compact undifferentiated cutis of repent, smooth, cylindrical hyphae, 2–7 μm wide, with dominant parietal pigment; **SUPRAPELLIS** not or very scarcely gelatinized. **STIPITPELLIS** a cutis of elongate hyphae. **CLAMP-CONNECTIONS** present at all septa. **THROMBOPLEROUS HYPHAE** not seen.

HABITAT. Under *Cistus symphytifolius* Lam. near some trees of *Pinus canariensis*, in small groups. Autumn.

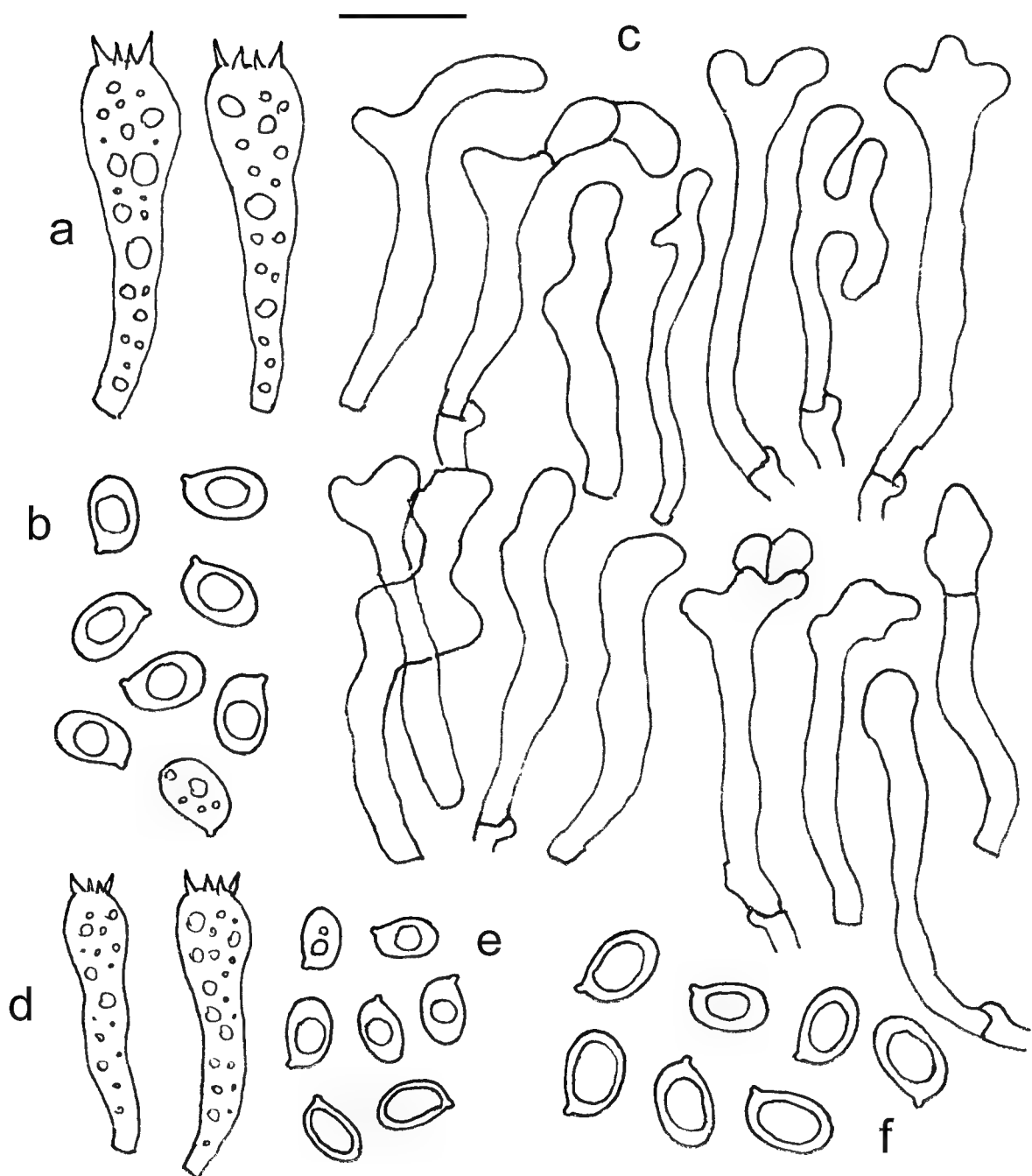


FIGURE 2. Basidiomes. Microscopical features.

Lyophyllum brunneum (from the holotypus). a. Basidia. b. Spores. c. Cheilocystidia.

L. infidum (from the holotypus). d. Basidia. e. Spores.

L. pseudoloricatum (from the holotypus). f. Spores.

Scale bar = 10 μ m

COMMENTS. *Lyophyllum infidum* is well characterized by the pale greyish-brown tinges and central umbo of the pileus, the nearly unchanging surface when handled, the farinaceous smell and taste, and, micromorphologically, by the small, ellipsoid spores. *Lyophyllum bonii* Contu 1996 (Consiglio & Contu 2002) has a similarly tinged pileus, but it lacks an umbo, has decurrent lamellae, and larger, less elongate spores. At first we thought that our collection was an ecoform of *L. semitale* var. *intermedium* Romagn. 1987 (Romagnesi 1987, Bon 1999, Consiglio & Contu 2002), a variety repeatedly collected by the first author

in La Palma (material revised by M. Contu), but this has bigger spores with an ogival apex and a clear suprahilar depression, a different (non-farinaceous) smell and taste, and larger basidia (Clémenton 1986, Kalamees 2004). *Lyophyllum brunneo-ochrascens* E. Ludw. 2001, also characterized by a brown to fuscous-brown, pruinose pileus surface and farinaceous smell and taste, differs in having much larger spores, viz. “7–9.5 × 4.5–6 µm” in the protologue (Ludwig 2001) whilst *L. pulvis-horrei* E. Ludw. & Koeck 2001 (Ludwig 2001), another small-sized species, is easily distinguished by its non-pruinose umbonate pileus, more adnate to decurrent lamellae, different smell, and narrower, subglobose to broadly ellipsoid spores. Moreover, *L. pulvis-horrei* grows caespitose in open grasslands (Ludwig 2001).

Finally, *L. ignobile* (P. Karst.) Clémenton 1982 is an additional European species with small to medium-sized basidiomes and ellipsoid spores, but it is distinguished by usually darker tinges, more elongate and narrower spores, and a different (non-farinaceous) smell and taste (Clémenton 1982, 1986). Among the extra-European species cited by Clémenton & Smith (1983), we should mention *L. fuligineum* (Peck) Singer 1942, which Peck described as possessing a fuscous pileus, grey stipe, and blackening context with farinaceous smell and taste (Saccardo 1891). *Lyophyllum fuligineum*, however, clearly differs from *L. infidum* by the fleshy context, darker, non-umbonate pileus, stouter (thicker) stipe, and larger, more elongate spores (Singer 1942; Clémenton 1982—type-study of *Tricholoma fuligineum* Peck 1888).

Lyophyllum pseudoloricatum Dähncke, Contu & Vizzini, sp. nov. FIGS. 1c, 2f
MYCOBANK MB515108

Pileus 3–7.5 cm *latus*, *carnosus*, *cartilagineus*, *convexus*, *brunneus*, *rugulosus*. *Lamellae* *parce confertae*, *uncinato-adnatae*, *cremeae*. *Stipes* 4–5 × 1.5–2 cm, *solidus*, *clavatus* *ed* *haud bulbosus*, *albus*, *politus*. *Caro firma*, *alba*, *immutabilis*. *Odor* *saporque debiles*. *Sporae* 6–8(–8.4) × 4.5–6 µm, *late ellipsoideae vel ellipsoideae*, *obtusae*, *leves*. *Basidia* 30–40 × 8–10 µm, *tetraspora*. *Cellulae marginales nullae vel incospicuae*. *Pilei cutis ex hyphis iacentibus*, *radialibus*, 2–5 µm *latis efformata*. *Fibulae numerosae*.

HOLOTYPE: *Hispania, Insulae Canariae, in insula La Palma dicta, ad locum dictum Pajonales, 23.XI.2007, leg. R.M. Dähncke (TO HG1727).*

ETYMOLOGY. The specific epithet refers to the resemblance of this species to the morphologically closely related *L. loricatum*.

PILEUS 4–7 cm wide, fleshy, elastic-cartilaginous, broadly convex with an inrolled margin in young stages, expanding, without umbo, dry, glabrous, rugulose, brown (Se 691–693) with a darker center (Se 707, 711), hygrophanous and distinctly fading with age. **LAMELLAE** not very close to subdistant, uncinately adnate, moderately thick to thick, cream, not staining when bruised. **STIPE** 6–7 × 1.5–2 cm, solid, clavate, often with an inflate base, lacking a bulb, polished, white, stuffed with a thick white pith. **CONTEXT** thick in the disk but

progressively thinner towards the pileus margin, white, unchanging; smell and taste none.

SPORES 6–8(–8.4) × 4.5–6 µm, on average 7.6 × 5.4 µm, hyaline, cyanophilous, carminophilous, broadly ellipsoid to ellipsoid, smooth, with a single, central oil-drop, apex obtuse. BASIDIA 30–40 × 8–10 µm, four-spored, clavate, with basal clamp-connection; SUBHYMENIUM made up of inflated elements. HYMENOPHORAL TRAMA regular, consisting of hyaline hyphae. MARGINAL CELLS 20–40 × 2–4.5 µm, rare, not well-differentiated, not peculiar, cylindrico-flexuose, hyaline, thin-walled. PILEIPELLIS a xerocutis of differentiate, repent, smooth, cylindrico-clavate hyphae, 2–5 µm wide, with dominant parietal pigment, SUPRAPELLIS an ixocutis of very thin elements; SUBPELLIS and PILEI TRAMA with progressively wider hyphae. STIPITPELLIS a cutis of elongate hyphae intermixed with abundant thromboplerous hyphae. CLAMP-CONNECTIONS present at all septa. THROMBOPLEROUS HYPHAE abundant.

HABITAT. Caespitose in mixed woods with *Pinus canariensis* or *P. radiata*. Autumn.

ADDITIONAL MATERIAL STUDIED: Spain, Canary Islands, La Palma, Hoyo del Rehielo, 23.XI.2007, leg. R.M. Dähncke (TO HG1728); – ditto, in the very same habitat, 25.X.2008, leg. R.M. Dähncke (TO HG1729); – ditto, Pared Vieja, in a pine wood with *Pinus radiata*, 25.X.2008, R.M. Dähncke (TO HG1730).

COMMENTS. In general appearance, *L. pseudoloricatum* greatly resembles *L. loricatum*, which also shares the same cartilaginous context. The two species are, however, readily distinguished by the spore shape: broadly ellipsoid in our new species in contrast to globose in *L. loricatum* as well as in most species in section *Aggregata*. To our knowledge, the sole species of this section having non-globose spores is *L. subglobisporum* (Consiglio & Contu 2002), which was also collected by the first author in La Palma (material revised by M. Contu); *L. subglobisporum*, however, is readily distinguished by the broader spores, smaller and less elongate basidia, and non-cartilaginous context. Among the extra-European species we have not been able to find anything similar.

***Lyophyllum pseudoloricatum* f. *lactellum* Dähncke, Contu & Vizzini, f. nov.**

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FIG. 1D

A typo solum differt basidiocarpo albo-lacteo.

HOLOTYPE: *Hispania, Insulae Canariae, in insula La Palma dicta, ad locum dictum Hoyo del Rehielo, 15.XII.2006, leg. R.M. Dähncke (TO HG1731).*

ETYMOLOGY. The epithet refers to the milky-coloured pileus.

COMMENTS. Apart from the white colour, this agaric is fully identical to *L. pseudoloricatum*; therefore, we think that it should be regarded as a white form of the latter. This record is very interesting because until now white forms of usually coloured species were not known in *Lyophyllum* s.l.

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Literature cited

- Baroni TJ. 1981. The genus *Rhodocybe* Maire (*Agaricales*). Beihefte zur Nova Hedwigia 67: 1–194.
- Bon M. 1999. Flore Mycologique d'Europe. Les Collybio-marasmioïdes et ressemblants. Doc Mycol Mémoire hors-série n. 5. Amiens. 171 pp.
- Cléménçon H. 1982. Types studies and typifications in *Lyophyllum* (*Agaricales*). I. Staining species. Mycotaxon 15: 67–94.
- Cléménçon H. 1986. Schwärzende *Lyophyllum*-Arten Europas. Zeitschr für Mykol 52 (1): 61–84.
- Cléménçon H, Smith AH. 1983. New species of *Lyophyllum* (*Agaricales*) from North America and a key to the known staining species. Mycotaxon 17: 379–437.
- Consiglio G, Contu M. 2002. Il genere *Lyophyllum* P. Karst. emend. Kühner, in Italia. Riv Micol 45(2): 99–181.
- Hofstetter V, Cléménçon H, Vilgalys R, Moncalvo J-M. 2002. Phylogenetic analyses of the *Lyophylleae* (*Agaricales*, *Basidiomycota*) based on nuclear and mitochondrial rDNA sequences. Mycol Res 106: 104–1059.
- Holmgren PK, Holmgren NH. 1998. (continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> (accessed 19 July 2009).
- Kalamees K. 2004. Palearctic *Lyophyllaceae* (*Tricholomataceae*) in Northern and Eastern Europe and Asia. Scripta Mycol 18: 3–134.
- Kirk PM, Ansell ME. 2003. Authors of Fungal Names. Index of Fungi Supplement. CAB International, Oxon, UK (electronic version).
- Ludwig E. 2001. Pilzkompedium, Bd.1 Beschreibungen: Die kleineren Gattungen der Makromyzeten mit lamelligem Hymenophor aus den Ordnungen *Agaricales*, *Boletales* und *Polyporales*. Eching.
- Romagnesi H. 1987. Sur la tribu des *Lyophylleae* Kühner (*Agaricales*, *Tricholomaceae*). Beitr Kenn Pilz Mittel III: 17–123.
- Saccardo PA. 1891. Sylloge Fungorum omnium hucusque cognitorum. IX. Supplementum universale. 1. *Agaricaceae-Laboulbeniaceae*. Patavii.
- Séguy E. 1936. Code Universel des Couleurs. Paul Chevalier, ed. Paris. 68 p. 48 pl.
- Singer R. 1942. Type studies on agarics. Lloydia 5: 97–135.

Typification and taxonomy of *Caloplaca aurantia*

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Abstract — The sample from the Arnold's Lichenes Exsiccati no 989: *Phycia aurantia*, deposited in M, is designated to serve as neotype of *Caloplaca aurantia*. The sample appears to be a topotype of *C. aurantia*. An overview is presented of the complicated history of the application and misuse of the name. Old literature references to *C. aurantia* should be confirmed by herbarium material, since the species was often confused with *C. flavescens*.

Key words — central Europe, lichenized fungi, lichens, *Teloschistales*

Introduction

Caloplaca aurantia belongs to a small group of lobate, saxicolous species unique within the large genus *Caloplaca* (*Teloschistales*, lichenized *Ascomycota*) on account of their lemon-shaped ascospores. The group also includes *C. aegaea* Sipman, *C. flavescens* (Huds.) J.R. Laundon, *C. fuerteventurae* van den Boom & Etayo and *C. thallincola* (Wedd.) Du Rietz. Despite several recent taxonomic treatments including these species (Nordin 1972, Wetmore & Kärnefelt 1998, Gaya 2009), *C. aurantia* remains the only taxon that has not been typified. Moreover, although the name *C. aurantia* is used unambiguously in recent literature, I have noticed that its intricate evolution since the 18th century sometimes causes confusion even today (Šoun & Vondrák 2008). Here I select a type and discuss the historical circumstances associated with this name.

Typification

Caloplaca aurantia (Pers.) J. Steiner, Sitzungsber. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Cl., Abt. 1, 105: 438, 1896

≡ *Lichen aurantius* Pers., Ann. Bot. (Usteri) 11: 14, 1794

Type – An Kalkfelsen beim Dorfe Wendershausen unweit Witzhausen an der Werra [Germany, Hesse], 1883, Dannenberg [Arnold's Lichenes Exsiccati no 989 sub *Phycia aurantia*, M (M-0127045)! – **neotype designated here**; PRM! – isoneotype].

- = *Physcia aurantia* (Pers.) Arnold, Flora 67: 246, 1884
- = *Caloplaca callopisma* [unranked] *aurantia* (Pers.) Hellb., Bih. K. Svenska Vet.-Akad. Handl., Afd. 3, 16(1): 60, 1890 [as "*Caloplaca callopisma* * *C. aurantia*"]
- = *Amphiloma aurantium* (Pers.) Müll. Arg., Hedwigia 31: 153, 1892
- = *Lichen sympageus* Ach., Lichenogr. Suec. Prodr.: 105, 1798
- = *Lecanora callopisma* Ach., Lichenogr. Univ.: 437, 1810
- Type – in muris et saxis Galliae [France], Dufour (H-Ach #1163A!, lectotype selected by Wetmore 1998).
- = *Callopisma vulgaris* De Not., Giorn. Botan. Ital., anno 2, tomo 2: 199, 1847

Caloplaca aurantia was described as *Lichen aurantius* by Persoon (1794). However, there is no specimen named *Lichen aurantius* present in Persoon's herbarium in L (Nordin 1972, G. Thijssse in litt. 2005). Despite the absence of a type specimen, however, the protologue (FIG. 1) is sufficiently detailed to lead one to a proper identification of *C. aurantia* according to current concepts. Any confusion with the potentially most similar species, *C. flavescens*, is avoided by the reference to flat, non-convex lobes. Arnold's Lichenes Exsiccati no 989 of *Physcia aurantia* was collected in 1883 by Dannenberg, most likely at the type locality. The exsiccate was distributed according to Grummann (1974) to C, DUKE, FH, FR, GOET, H, HAL, HSI, K, L, M, NY, O, PC, S, UPS, US, and W;

II. *Lichen aurantius, saxatilis, crusta foliacea tartarea: foliis inbricatis expansis obscure aurantiis, scutellis parvis concoloribus.*

Prov. elegans hæcce species ad rupes calcarias. (Prope Witgenhaussen in Haffia.)

Desc. Ambitus suborbicularis latitudine 3 — 4 unc., rupibus arcte adhærens foliis expansis adpressis, fibi invicem approximatis, planis finuatis, apice subcrenatis, colore obscure vitellinis. Substantia tartarea, fragili, hinc de rupibus se evellendum non finit.

Obs. Foliis nec convexis, nec pulposis, nec inter se distantibus, etiam magnitudine a Lich. *murorum* Hoffm. & *miniato* ejusd. differt. Sic quoque foliis latioribus & inprimis colore a Lich. *circinnato*, *versicolore* & *murali* discrepat.

FIG. 1. The original description of *Lichen aurantius* (Persoon 1794: 14).

989. — *Physcia aurantia* Pers. in Ust. Ann. 11, 1794 p. 14; 1795 p. 36.
L. sympagea Ach. prodr. 1798 p. 105, univ. p. 437.
 An Kalkfelsen beim Dorfe Wendershausen unweit Witzenhausen an
 der Werra (ubi Persoon plantam legit). 1883. **Dannenberg.**

FIG. 2. The label of Arnold's Lichenes Exsiccati no 989 of *Physcia aurantia* (M).

I have also found one in PRM. On the label (FIG. 2) it is claimed that the locality [the village of Wendershausen near Witzenhausen on the Werra] corresponds with Persoon's protologue [at Witzenhausen in Hassia], so this exsiccate specimen is regarded as a topotype. The locality is situated in the northern part of current German state of Hesse, and in Persoon's protologue Witzenhausen is very probably incorrectly spelled Witzenhausen. Arnold's exsiccate agrees well with Persoon's description — especially in its flat, deep orange lobes — while at the same time corresponding to the modern concept of *C. aurantia*; among other characters, the absence of a crystalline layer in the cortex distinguishes it from *C. flavesces*. For some reason, however, Arnold issued this collection as *Physcia aurantia*, a name that he usually misapplied to *C. flavesces*, instead of *Physcia callopisma* (Ach.) A. Massal., the name that he normally used for the true *C. aurantia* (Arnold 1884). I select here this exsiccate in M as the neotype of *C. aurantia*.

Development of taxonomy

The name *Lichen aurantius* introduced by Persoon (1794) was soon synonymized by Acharius (1798: 105) with a new name, *Lichen sympageus*. Acharius, however, had never seen Persoon's *L. aurantius*, as he himself noted; he likely just excerpted Persoon's original description and also the short note in a further Persoon publication (Persoon 1795). Fries (1871) later also pointed out that Acharius had never seen *L. sympageus* and that the species is absent from Acharius's herbarium. Although by citing an older synonym in the protologue Acharius made the name *L. sympageus* superfluous and illegitimate, it was adopted by some authors. Later, Acharius (1803) incorrectly reduced both *L. sympageus* and *L. aurantius* to synonymy with *Parmelia elegans* (Link) Ach. [= *Xanthoria elegans* (Link) Th. Fr.].

In 1810, Acharius adopted yet another concept. On the basis of specimens from different sites in Europe, he described *Lecanora callopisma* (= *C. aurantia*) with *Lichen sympageus* treated as its variety (*Lecanora callopisma* β *sympagea*) that differed only in its more strongly orange thallus color (Acharius 1810). During the 19th century various authors treated *L. callopisma* also under other genera, reflecting the evolution in taxonomy: *Aglaopisma vulgaris* (De Not.) De Not., *Amphiloma callopisma* (Ach.) Körb., *Callopisma vulgaris*, *Gasparrinia*

callopisma (Ach.) P. Syd., *Parmelia callopisma* (Ach.) Hepp, *Physcia callopisma*, *Placodium callopismum* (Ach.) Mérat, *Teloschistes callopismus* (Ach.) Trevis., and *Xanthoria callopisma* (Ach.) Th. Fr. Fries (1871) combined *Lecanora callopisma* into the currently accepted genus *Caloplaca*, however he included under this name also lichens from southern Scandinavia known today as *C. flavescens*; nevertheless some authors followed suit (e.g. Hellbom 1890).

Arnold (1881) stated that, in his opinion, *Lichen aurantius* is the oldest name for *Amphiloma heppianum* Müll. Arg. (= *C. flavescens*) described by Müller (1862). He probably based his opinion on specimens of *C. flavescens* that he saw in Meyer's herbarium determined as *L. callopisma* var. *aurantia* or *L. callopisma* var. *sympagea*. Subsequently Arnold (1884) incorrectly replaced the name *Physcia heppiana* (Müll. Arg.) Arnold with *Physcia aurantia* and this was probably the starting point for the misapplication of the epithet *aurantia* for next c. 70 years. Disagreeing with his concept, some authors (e.g. Hue 1886, Crombie 1894, Nylander 1896, Monguillon 1899) used Acharius's epithet *sympagea* for *Physcia heppiana*. From the end of 19th to the beginning of 20th century, three epithets (*aurantium*, *heppianum* and *sympageum*) were in use simultaneously for *C. flavescens* and two for *C. aurantia* (*aurantium* and *callopismum*; e.g., Flagey 1886, Sydow 1887, Hue 1896 and Nylander 1896).

As Nordin (1972) has noted, Hellbom's combination of *Caloplaca callopisma* * *aurantia* (Hellbom 1890: 60) does not refer to the correct material but is misapplied to *C. flavescens*. Steiner's later combination of *Caloplaca aurantia* (Steiner 1896: 438) probably refers to the correct lichen. The combination *C. aurantia* has been attributed to both Hellbom and Steiner, but as Laundon (1984) has indicated, only Steiner's combination is at species rank; the Hellbom combination is at an undesignated infraspecific rank, as indicated by the typography and explicitly stated in discussion (Hellbom 1890: 60–62).

Müller's combination of *Amphiloma aurantium* is worth mentioning because it was the first to correctly synonymize *L. aurantius* with *L. callopisma* (Müller 1892). This concept was subsequently adopted by some, but not all, lichenologists (e.g. Hue 1896, Rieber 1901, Migula 1929) in the first half of 20th century. Unfortunately Zahlbruckner (1931) also treated *C. aurantia* incorrectly as *C. heppiana* (Müll. Arg.) Zahlbr. (= *C. flavescens*).

After Poelt (1954) the species and names *C. aurantia* and *C. flavescens* (until Laundon 1984 as *C. heppiana*) have been used correctly in general, although some authors initially used these names for two different varieties within *C. aurantia* (Poelt 1954, 1969, Wade 1956, Alon & Galun 1971). Only a few authors persisted in using Zahlbruckner's concept after 1954 (e.g. Moruzi et al. 1967 and Werner 1956).

The intricate history of the application of the name *C. aurantia* means that all old literature references to this species require confirmation by herbarium

material, because some records obviously represent a different species, *C. flavescens*.

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Literature cited

- Acharius E. 1798. *Lichenographiae Suecicae Prodrömus*. Linköping.
- Acharius E. 1803. *Methodus qua omnes detectos lichenes*. Stockholm.
- Acharius E. 1810. *Lichenographia Universalis*. Göttingen.
- Alon G, Galun M. 1971. The genus *Caloplaca* in Israel. *Israel Jour. Bot.* 20: 273–292.
- Arnold F. 1881. *Lichenologische Fragmente XXV*. *Flora* 64: 305–315, 321–327.
- Arnold F. 1884. Die Lichenen der fränkischen Jura. I. Abtheilung. Aufzählung der Arten. *Flora* 67: 65–96, 145–173, 227–258, 307–338, 403–434, 549–596, 645–664.
- Crombie JM. 1894. A monograph of lichens found in Britain: being a descriptive catalogue of the species of the British Museum. Part I. London.
- Flagey C. 1886. Flore des lichens de Franche-Comté et de quelques localités environnantes. Partie II. *Mém. Soc. d'Émulation du Doubs* 1886: 201–378.
- Fries TM. 1871. *Lichenographia Scandinavica sive dispositio lichenum in Dania, Suecia, Norvegia, Fennia, Lapponia Rossica hactenus collectorum*. Vol. I *Archilichenes discocarpos continens*. Pars I. Uppsala.
- Gaya E. 2009. Taxonomical revision of the *Caloplaca saxicola* group (*Teloschistaceae*, lichenforming *Ascomycota*). *Bibliotheca Lichenologica* 101. Stuttgart, J. Cramer.
- Grummann V. 1974. *Biographisch-bibliographisches Handbuch der Lichenologie*. Lehre, Verlag von J. Cramer.
- Hellbom PJ. 1890. Bornholms Lafflora. *Bih. K. Svenska Vet.-Akad. Handl., Afd. 3*, 16(1): 1–119.
- Hue A. 1886. Addenda nova ad lichenographiam europaeam. Exposuit in *Flora Ratisbonensi* Dr. W. Nylander. In ordine systematico disposuit. Pars prior. Paris.
- Hue A. 1896. Lichens d'Aix-les-Bains. *J. de Bot.* 10: 3–15, 26–32, 33–37, 87–92, 93–98, 146–148, 149–156, 173–176, 190–194.
- Laundon JR. 1984. Studies in the nomenclature of British lichens I. *Lichenologist* 16: 53–57.
- Migula W. 1929. *Kryptogamen-Flora von Deutschland, Deutsch-Österreich und der Schweiz*. Flechten. Band 4. Teil 1. Leipzig.
- Monguillon T. 1899. Catalogue des lichens du Département de la Sarthe. *Bull. Acad. Internat. Géogr. Bot.* 8: 79–86, 105–108, 113–117, 155–163, 203–209, 213–219, 251–258, 282–285, 310–318.
- Moruzi C, Petria E, Mantu E. 1967. Catalogul lichenilor din România. *Acta Bot. Horti Bucurest.* 1967: 1–389.
- Müller J. 1862. Principes de classification des lichens et énumération des lichens de Genève. *Mém. Soc. phys. et hist. nat. de Genève* 16: 343–433.
- Müller J. 1892. Lichenes Persici a cl. Dr. Stapf in Persia lecti. *Hedwigia* 31: 151–159.
- Nordin I. 1972. *Caloplaca* sect. *Gasparrinia* in Nordeuropa. *Taxonomiska och Ekologiska Studier*. Uppsala, Skriv Service AB.

- Nylander W. 1896. Les lichens des environs de Paris. Paris, P. Schmidt.
- Persoon CH. 1794. Nähere Bestimmung und Beschreibungen einiger sich nahe verwandten Pflanzen. Ann. Bot. (Usteri) 11 [= Neue Ann. Bot. (Usteri) 5]: 1–32.
- Persoon CH. 1795. Botanische Beobachtungen. Ann. Bot. 14: 33–39.
- Poelt J. 1954. Die gelappten Arten der Flechtengattung *Caloplaca* in Europa mit besonderer Berücksichtigung Mitteleuropas. Mitt. Bot. Staatssamml. München 1954(11): 11–31.
- Poelt J. 1969. Bestimmungsschlüssel europäischer Flechten. Lehre, J. Cramer.
- Rieber X. 1901. Zur Flechtenflora der Umgebung von Ehingen a.D. Ein Beitrag zur württembergischen Lichenologie und zur Oberamtsbeschreibung. Wiss. Beilage zum Jahresber. K. Gymnasiums in Ehingen 1900/1901: 1–32.
- Steiner J. 1896. Beitrag zur Flechtenflora Südpersiens. Sitzungsber. Kaiserl. Akad. Wiss. Wien, Math.-Naturwiss. Cl., Abt. 1, 105: 436–446.
- Sydow P. 1887. Die Flechten Deutschlands. Anleitung zur Kenntniss und Bestimmung der deutschen Flechten. Berlin.
- Šoun J, Vondrák J. 2008. *Caloplaca aurantia* and *Caloplaca flavescens* (Teloschistaceae, lichen-forming fungi) in the Czech Republic; with notes to their taxonomy and nomenclature. Czech Mycology 60: 275–291.
- Wade AE. 1956. Lichenological notes. I. Trans. British Mycol. Soc. 39(4): 416–422.
- Werner RG. 1956. Notes de lichenologie libano-syrienne. III. Bull. Soc. Bot. France 103(7-8): 461–467.
- Wetmore CM, Kärnefelt EI. 1998. The lobate and subfruticose species of *Caloplaca* in North and Central America. Bryologist 101: 230–255.
- Zahlbruckner A. 1931. Catalogus Lichenum Universalis. 7. Leipzig, Borntraeger.

New combinations in *Raffaelea*, *Ambrosiella*, and *Hyalorhinocleriella*, and four new species from the redbay ambrosia beetle, *Xyleborus glabratus*

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Abstract — Female adults of the redbay ambrosia beetle, *Xyleborus glabratus* (Coleoptera: Curculionidae: Scolytinae), from the southeastern USA were individually macerated and serially diluted onto culture media for isolation of fungal symbionts. Six *Raffaelea* species were recovered: *R. lauricola*, *R. arxii*, and four new species: *R. subalba*, *R. ellipticospora*, *R. fusca* and *R. subfusca*. Phylogenetic analyses of LSU rDNA sequences placed these mycangial inhabitants and other species of *Raffaelea*, as well as some species of *Ambrosiella* associated with ambrosia beetles, into a monophyletic, asexual clade within *Ophiostoma*. New combinations in *Raffaelea* are made for some *Ambrosiella* species and *Dryadomyces amasae*. Ambrosia beetle symbionts with *Ceratocystis* affinities, including *A. trypodendri* comb. nov., are retained in *Ambrosiella*, but *Ambrosiella* species associated with bark beetles are transferred to the anamorph genus *Hyalorhinocleriella* as *H. ips*, *H. macrospora*, and *H. tingens*.

Key words — *Grosmannia*, *Leptographium*, *Ophiostomataceae*, *Ophiostomatales*, *Scolytidae*

Introduction

The ecology of only a small fraction of the approximately 3400 species of ambrosia beetles (Coleoptera: Curculionidae: Scolytinae and Platypodinae) has been studied in detail (Batra 1963, Farrell et al. 2001, Francke-Grosmann 1967), and relatively few of their fungal symbionts have been described (Batra 1968, Massoumi Alamouti et al. 2009). Ambrosia beetles are polyphyletic and were derived from bark beetles in at least seven evolutionary events (Farrell et al. 2001). Ecologically, ambrosia beetles are distinguished from bark beetles by laying eggs along tunnels in the sapwood of dead or dying trees, while bark

beetles lay their eggs along galleries in the nutrient-rich inner bark (phloem) of trees (Harrington 2005). Ambrosia beetle adults and larvae feed on symbiotic fungi that grow in the otherwise nutrient-poor sapwood (Batra 1963, Francke-Grosmann 1967). The symbionts produce small conidiophores in tight clusters (sporodochia), which are suitable for grazing by ambrosia beetle larvae and adults (Batra 1968, Harrington 2005). Budding spores of the fungal symbionts are carried in one or both sexes of adult ambrosia beetles in specialized sacs called mycangia (Batra 1963, Beaver et al. 1989, Francke-Grosmann 1967, Six 2003). The fungal symbionts of the beetles are asexual (Batra 1963), and their reduced morphology has led to ambiguous classification systems, at least until the common application of DNA sequence analyses (Cassar & Blackwell 1996, Jones & Blackwell 1998, Rollins et al. 2001).

A comprehensive taxonomic evaluation of fungi associated with ambrosia beetles has not been conducted since Batra (1968), who placed most of the known species in the anamorph genera *Ambrosiella* and *Raffaelea*. The type species of these genera are placed by phylogenetic analyses within the ascomycete genera *Ceratocystis* Ellis & Halst. and *Ophiostoma* Syd. & P. Syd., respectively (Cassar & Blackwell 1996, Jones & Blackwell 1998). Most of the ambrosia beetle symbionts fall within the *Ophiostoma* clade (Gebhardt et al. 2005, Kolarik & Hulcr 2009, Massoumi Alamouti et al. 2009). Traditionally, species of *Ambrosiella* and *Raffaelea* have been distinguished from other anamorphs of *Ophiostoma* based on the clustering of conidiophores into sporodochia, an adaptation for serving as food for insect grazers (Harrington 2005). However, sporodochium formation is found in at least three lineages within the *Ophiostoma* group, and sporodochial anamorphs of *Ophiostoma*-like species could be better split by their ambrosia beetle vs. bark beetle associations (Harrington 2005, Harrington et al. 2008, Massoumi Alamouti et al. 2009).

Ambrosiella and *Raffaelea* were originally distinguished based on annellidic vs. sympodial proliferation of the conidiogenous cells, respectively (Batra 1968). However, many *Raffaelea* species have percurrent (annellidic) proliferation of conidiogenous cells (Gebhardt & Oberwinkler 2005), and Batra's distinction appears to have little taxonomic value (Harrington 2005, Harrington et al. 2008). The type species of *Ambrosiella* (*A. xylebori*) is within the *Ceratocystis* clade, and true *Ambrosiella* species produce conidia from deep-seated phialides (Gebhardt et al. 2005, Harrington 2009, Kolarik & Hulcr 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009). Most of the ambrosia beetle symbionts related to *Ophiostoma* species, including the type species of *Raffaelea*, have been described as species of *Raffaelea* (Kubono & Ito 2002, Massoumi Alamouti et al. 2009). Species of *Raffaelea*, along with some *Ambrosiella* species and *Dryadomyces amasae*, appear to form a monophyletic group within *Ophiostoma* (Gebhardt et al. 2005, Massoumi Alamouti et al.

2009). Harrington et al. (2008) emended *Raffaelea* to include all ambrosia beetle symbionts related to *Ophiostoma*.

It is generally believed that only one or a few fungal symbionts are tightly associated with a particular ambrosia beetle species (Batra 1963, Funk 1970). However, our isolations (Harrington & Fraedrich, unpublished) from adult *Xyleborus glabratus* Eichh., the redbay ambrosia beetle, resulted in six species of *Raffaelea*. The most commonly isolated species was *R. lauricola*, which causes laurel wilt on redbay [*Persea borbonia* (L.) Spreng.] and other species in the *Lauraceae* in the southeastern USA (Fraedrich et al. 2008, Harrington et al. 2008). Thus far, *R. lauricola* is the only true vascular wilt fungus associated with an ambrosia beetle (Fraedrich et al. 2008). The beetle is native to Asia (e.g., India, Japan, and Taiwan), usually associated with aromatic plant species, especially species in the family *Lauraceae* (Wood & Bright 1992). The redbay ambrosia beetle was first discovered near Savannah, Georgia, USA, probably introduced in solid wood packing material. Adult females have paired, mandibular mycangia (Fraedrich et al. 2008), and *R. lauricola* can be readily recovered and quantified from beetles by grinding the head of the beetles and dilution plating. Like other ambrosia beetle symbionts, *R. lauricola* can grow in a yeast phase within the mycangium of its ambrosia beetle (Fraedrich et al. 2008, Harrington 2005).

Here we describe four new species of *Raffaelea* isolated from *X. glabratus* recovered from redbay in South Carolina, Georgia, and Florida. Analyses of rDNA sequences infer that these four new species are members of a monophyletic group of ambrosia beetle symbionts that are asexual species of *Ophiostoma*. All beetle symbionts described in the genera *Raffaelea* and *Ambrosiella* are reevaluated taxonomically. Species associated with bark beetles that were previously described as *Ambrosiella* are transferred to *Hyalorhinocladiella*.

Materials and methods

Cultures

Adult, female *X. glabratus* were excavated from naturally infested trees of *P. borbonia* with laurel wilt. Beetles were individually macerated in glass tissue grinders, the macerate was serially diluted, and aliquots of the dilutions were plated on malt extract (1% Difco malt extract) agar amended with 200 ppm cycloheximide and 100 ppm streptomycin (CSMA) in 90 mm diameter Petri dishes (Harrington 1992). Cycloheximide media are semi-selective for *Ophiostoma* but do not allow for growth of *Ceratocystis* species or true *Ambrosiella* species (Cassar & Blackwell 1996, Harrington 1981). Representatives of different mycelial phenotypes on CSMA were transferred to separate plates and deposited in the collection of the senior author, and at least three isolates of each putative species were used for rDNA sequencing (TABLE 1). Cultures of other *Raffaelea* and *Ambrosiella* species were obtained from the Centraalbureau voor Schimmelcultures (CBS) (TABLE 1).

TABLE 1. Collection numbers, location, associated insect, SSU and LSU rDNA GenBank accession numbers, and new combinations and synonyms for isolates of *Ambrosiella*, *Raffaelea*, *Ophiostoma*, and *Leptographium*.

SPECIES	NEW COMBINATIONS AND SYNONYMS	ISOLATE NUMBER ^a	LOCATION	ASSOCIATED INSECT	SSU SEQUENCE	LSU SEQUENCE
<i>A. brunnea</i>	= <i>Raffaelea brunnea</i>	C2229, CBS 378.68	Unknown	<i>Monarthrum</i> sp.	EU170280	EU177457
<i>A. gnathotrichi</i>	= <i>R. gnathotrichi</i>	C2219, CBS 379.68*	Colorado, USA	<i>Gnathotrichius retusus</i>	EU170282	EU177460
<i>A. ips</i>	= <i>Hyalorhinochlaediella ips</i>	C1572, CBS 435.34*	Minnesota, USA	<i>Ips</i> sp.	EU170276	
<i>A. macrospora</i>	= <i>H. macrospora</i>	C2231, CBS 367.53	Sweden	<i>I. acuminatus</i>	EU170284	EU177468
<i>A. sulcati</i>	= <i>R. canadensis</i>	C592, CBS 805.70*	British Columbia, Canada	<i>G. sulcatus</i>	EU170281	EU177459
<i>A. sulphurea</i>	= <i>R. sulphurea</i>	C593, CBS 380.68*	Kansas, USA	<i>Xyleborus saxeseni</i>	EU170272	EU177463
<i>A. tingens</i>	= <i>H. tingens</i>	C2232, CBS 366.53	Sweden	Insect tunnel	EU170277	EU177474
<i>R. albimanens</i>		C2223, CBS 271.70*	South Africa	<i>Platypus externedentatus</i>	EU170269	EU177452
<i>R. ambrosiae</i>		C2225, CBS 185.64*	United Kingdom	<i>Platypus cylindrus</i>	EU170278	EU177453
<i>R. arxii</i>		C2218, CBS 273.70*	South Africa	<i>X. torquatus</i>	EU170279	EU177454
		C2372	Georgia, USA	<i>X. glabratus</i>		EU177455
<i>R. canadensis</i>		C2398	South Carolina, USA	<i>X. glabratus</i>		EU177456
		C2233, CBS 168.66*	British Columbia, Canada	<i>P. wilsonii</i>	EU170270	EU177458
<i>R. ellipticospora</i>		C2224, CBS 326.70	South Africa	<i>P. externedentatus</i>	EU170275	EU177467
		C2346	South Carolina, USA	<i>X. glabratus</i>		EU177444
		C2350	South Carolina, USA	<i>X. glabratus</i>		EU177445
<i>R. fusca</i>		C2395, CBS 121569*	South Carolina, USA	<i>X. glabratus</i>		EU177446
		C2254	Florida, USA	<i>X. glabratus</i>		EU177447
		C2336	South Carolina, USA	<i>X. glabratus</i>		EU177448
		C2394, CBS 121570*	South Carolina, USA	<i>X. glabratus</i>		EU177449
<i>R. lauricola</i>		C2203	South Carolina, USA	<i>X. glabratus</i>	EU123076	

	C2204	South Carolina, USA	<i>X. glabratus</i>	EU170266	
	C2214	South Carolina, USA	<i>X. glabratus</i>		
	C2227	Georgia, USA	<i>Xylosandrus crassiusculus</i>	EU170267	
	C2245	Georgia, USA	<i>X. glabratus</i>		EU177438
	C2258	Florida, USA	<i>X. glabratus</i>		EU177439
	C2339, CBS 121567*	South Carolina, USA	<i>X. glabratus</i>		EU177440
<i>R. montetyi</i>	C2221, CBS 463.94*	France	<i>P. cylindrus</i>	EU170283	
	C2220, CBS 451.94	Portugal	<i>P. cylindrus</i>		EU177461
<i>R. subalba</i>	C2368	Georgia, USA	<i>X. glabratus</i>		EU177441
	C2388	South Carolina, USA	<i>X. glabratus</i>		EU177442
	C2401, CBS 121568*	South Carolina, USA	<i>X. glabratus</i>		EU177443
<i>R. subfusca</i>	C2253	Florida, USA	<i>X. glabratus</i>	EU170268	
	C2335, CBS 121571*	South Carolina, USA	<i>X. glabratus</i>		EU177450
	C2352	South Carolina, USA	<i>X. glabratus</i>		EU177473
	C2380	Georgia, USA	<i>X. glabratus</i>		EU177451
<i>R. sulcati</i>	C2234, CBS 806.70*	British Columbia, Canada	<i>G. sulcatus</i>	EU170271	EU177462
<i>R. tritirachium</i>	C2222, CBS 726.69*	Pennsylvania, USA	<i>M. mali</i>	EU170273	EU177464
<i>Raffaelea</i> sp.	C1941	South Carolina, USA		EU170274	
	C1943	South Carolina, USA			EU177465
	C2262	South Carolina, USA	<i>X. glabratus</i>		EU177466
<i>O. huntii</i>	C583	Michigan, USA			EU177469
<i>O. ips</i>	C2308	California, USA	<i>Orthotomicus erosus</i>		EU177470
<i>O. serpens</i>	C30, CBS 141.36*	Italy			EU177471
<i>L. abietinum</i>	C1883	Alaska, USA			EU177472

*Collection numbers are those of the senior author or the Centraalbureau voor Schimmelcultures (CBS). Isolates denoted with an asterisk are from the holotype.

DNA sequencing and phylogenetic analyses

Isolates were grown on MYEA (2% Difco malt extract, 0.2% Difco yeast extract, and 1.5% agar) for 4–10 days at room temperature prior to DNA extraction. Mycelium was scraped from the surface, and DNA was extracted using PrepMan™ Ultra (Applied Biosystems, Foster City, CA). Amplification and sequencing of portions of the SSU (small subunit, 18S) rDNA and LSU (large subunit, 26S) rDNA were performed as described (Fraedrich et al. 2008). Primers for amplification and sequencing of the SSU rDNA included NS1, NS2, NS3, NS4, NS5, NS6, NS7, and NS8 (White et al. 1990) and SR1R and SR6 (Vilgalys & Hester 1990). The SR1R/SR6 products were cloned into pGEM T-easy vector (Promega Inc., Madison WI) and sequenced with flanking vector primers U (5'-TGTAACGACGGCCAGT-3') and R-1 (5'-CAGGAAACAGCTATGACC-3'), plus the internal primers NS2, NS3, NS5, and NS6. A portion of the LSU gene was amplified with primers LROR and LR5, and the PCR products were sequenced with primers LROR and LR3 (White et al. 1990). All sequences were generated at the Iowa State University DNA Sequencing and Synthesis Facility.

Phylogenetic analyses utilized SSU and LSU sequences available in GenBank as well as new sequences generated in this study (TABLE 1). Parsimony analysis and bootstrapping were carried out in PAUP 4.0b10 (Sinauer Associates, Sunderland, Massachusetts).

Species descriptions

Cultures were grown on malt extract agar (MEA, 1% Difco malt extract and 1.5% agar) at 25 C in the dark. Growth at 5, 10, 15, 20, 25, 30 and 35 C was also determined on MEA. Cycloheximide tolerance was determined on MEA amended with 100 ppm cycloheximide, but the cycloheximide was dissolved in ethanol before adding to the autoclaved medium. Colors of cultures on MEA followed the nomenclature of Rayner (1970).

Representative cultures were deposited in the Centraalbureau voor Schimmelcultures, and herbarium specimens have been deposited in the U.S. National Fungus Collections (BPI).

Results

Six filamentous fungal species were isolated from 39 adult female *X. glabratus*. Each of the six species was isolated in substantial numbers (greater than 300 colony forming units) from the surface-sterilized head of at least one beetle, suggesting that they were growing in the mycangium of the beetle, and most beetles yielded more than one fungal species. Each of the six fungal species tolerated cycloheximide, and they had SSU and LSU sequences similar to those of other *Ophiostoma*-like fungi that have been associated with ambrosia beetles (FIGS. 1 and 2). All six species had small, inconspicuous conidiophores that produced conidia from their tips, with the conidiogenous cells proliferating percurrently, with no conspicuous scars. All produced blastospores, that is, conidia budded from conidia to form a conspicuous yeast phase on the surface of cultures.

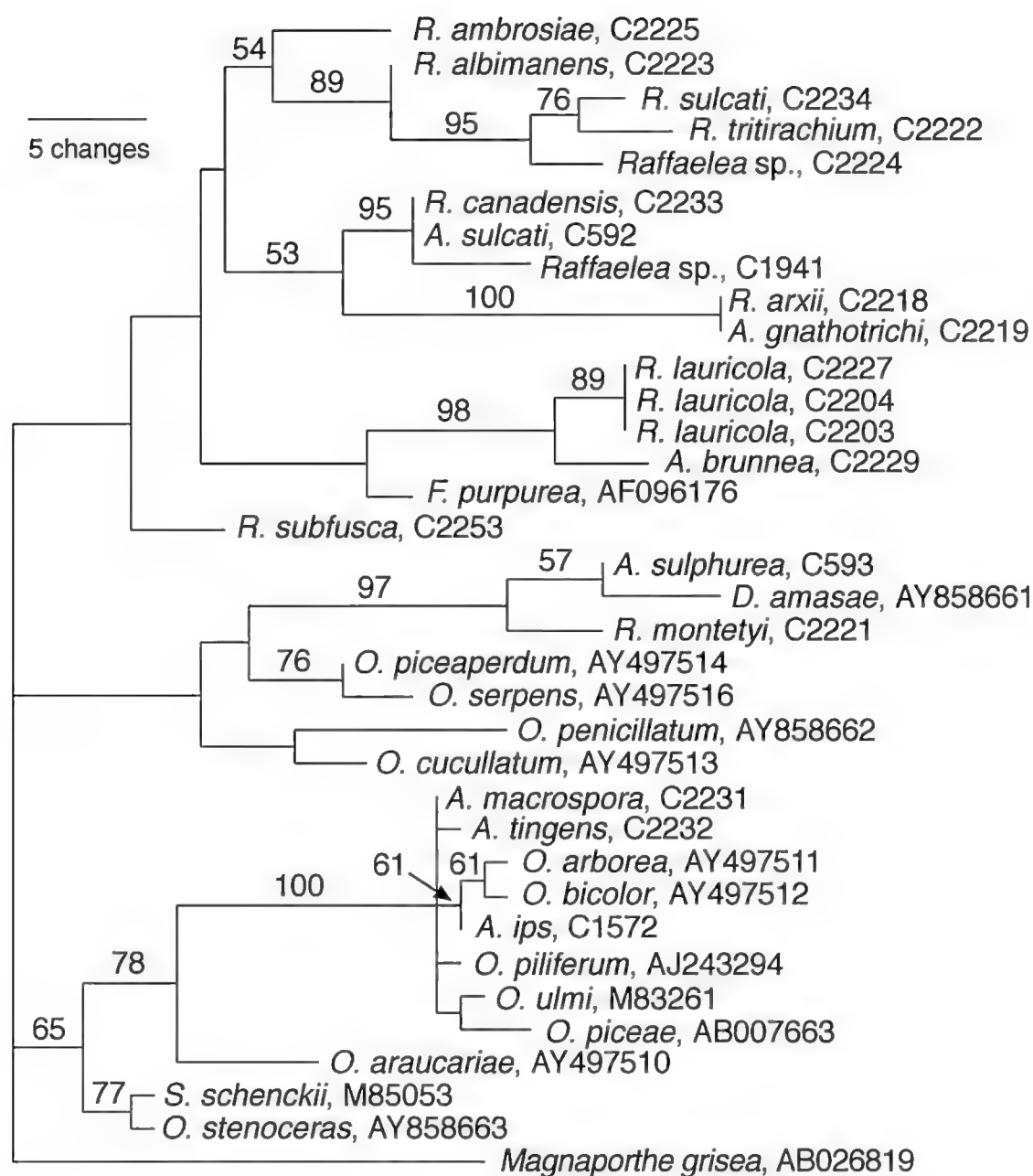


FIG. 1. One of two most-parsimonious trees of ambrosia beetle symbionts in the genera *Raffaelea*, *Ambrosiella*, and *Dryadomyces*, other *Ambrosiella* species associated with bark beetles, representative *Ophiostoma* species, *Fragosphaeria purpurea*, and *Sporothrix schenckii* based on sequences of SSU rDNA. The tree was rooted to *Magnaporthe grisea*. Isolate numbers (beginning with C) or GenBank accession numbers follow each taxon label. Consistency index = 0.5808, homoplasy index = 0.4192, retention index = 0.8238, and rescaled consistency index = 0.4785. Bootstrap values greater than 50% are shown above the branches.

The species isolated were distinguished from each other by mycelial morphology (FIG. 3), conidial morphology (FIG. 4), and analysis of LSU sequences (FIG. 2). The most commonly isolated species was *R. lauricola*, the cause of laurel wilt (Harrington et al. 2008), and another species was shown by LSU sequence to be *R. arxii*. Four species were undescribed species of *Raffaelea*. Detailed results of the isolations will be published elsewhere.

Phylogenetic analyses

Some of the species had SSU rDNA sequences with large introns that were unique to a single taxon, and these were eliminated from the analyses, leaving 1026 aligned characters, six of which were eliminated because of ambiguous alignment. Gaps were treated as a “fifth base,” the characters were unordered, and all characters had equal weight. Of the 1020 characters, 919 were constant and 30 of the variable characters were parsimony uninformative, leaving 71 parsimony-informative characters. Two most parsimonious trees of 198 steps were generated from the SSU dataset (FIG. 1). Most of the major branches had little or no bootstrap support, and ambrosia beetle symbionts did not group into a single monophyletic group. However, *R. sulcati*, *R. tritirachium*, and an isolate submitted to CBS as *R. canadensis* (C2224) grouped together. Another group consisted of a culture from the holotype of *R. canadensis*, *A. sulcati*, and an unidentified *Raffaelea* species (FIG. 1). *Raffaelea montetyi*, *A. sulphurea*, and *D. amasae* also grouped together. The laurel wilt pathogen, *R. lauricola*, grouped with *A. brunnea*. *Raffaelea arxii* and *A. gnathotrichi* had an identical SSU sequence. *Ambrosiella tingens*, *A. macrospora*, and *A. ips*, which have been associated with bark beetles (Harrington 2005), grouped with *Ophiostoma arborea* (Olchow. & J. Reid) Yamaoka & M.J. Wingf., *O. bicolor* R.W. Davidson & D.E. Wells, *O. piliferum* (Fr.) Syd. & P. Syd., *O. ulmi* (Buisman) Nannf., and *O. piceae* (Münch) Syd. & P. Syd. (Fig. 1).

The partial LSU rDNA sequences were treated as in the SSU dataset, but no intron was detected. The LSU dataset had 561 aligned characters, 346 characters were constant, and 41 characters were parsimony-uninformative, leaving 174 parsimony-informative characters. A single most-parsimonious tree of 643 steps was found (FIG. 2). A weakly supported branch (53% bootstrap support) connected all of the sampled ambrosia beetle symbionts, including the four new species isolated from *X. glabratus*. Some of the *Ophiostoma* species with *Leptographium* Lagerb. & Melin anamorphs were sister to the group of ambrosia beetle symbionts, but this branch had only weak bootstrap support (55%). Two species (*R. arxii* and *A. gnathotrichi*) with identical SSU sequences (FIG. 1) had differing LSU sequences, but they grouped together with strong

FIG. 2. The most-parsimonious tree of ambrosia beetle symbionts in the genera *Raffaelea* and *Ambrosiella*, other *Ambrosiella* species associated with bark beetles, and representative *Ophiostoma*, *Leptographium*, and *Fragosphaeria* species based on sequences of LSU rDNA. The tree was rooted to *Cryphonectria parasitica* and *Lecythophora decumbens*, allowing both the outgroup and ingroup taxa to collapse in a polytomy. Isolate numbers (beginning with C) or GenBank accession numbers follow each taxon label. Names of new species are in bold. New sequences of isolates from holotypes are followed by an asterisk. Consistency index = 0.4697, homoplasy index = 0.5303, retention index = 0.8253, and rescaled consistency index = 0.3876. Bootstrap values greater than 50% are shown above the branches.



bootstrap support (FIG. 2). The holotypes of *R. canadensis* and *A. sulcati* had nearly identical LSU sequences, and *A. sulphurea* and *R. montetyi* grouped together, as did *R. lauricola* and *A. brunnea*. The *Ambrosiella* species associated with bark beetles (*Ambrosiella tingens*, *A. macrospora*, and *A. ips*) grouped with *O. ips* (Rumbold) Nannf., *O. piceae*, *O. piliferum*, and related *Ophiostoma* species (FIG. 2).

Taxonomy

Raffaelea Arx & Hennebert emend. T.C. Harr., Mycotaxon 104: 401. 2008

= *Dryadomyces* Gebhardt, Mycological Research 109: 693. 2005.

TYPE SPECIES: *Raffaelea ambrosiae* Arx & Hennebert

Conidiophores single to aggregated in sporodochia, hyaline, unbranched or sparingly branched, one-celled to septate, producing conidia holoblastically. Conidiogenous cells proliferating percurrently or sympodially, leaving denticles, inconspicuous scars, or annellations. Conidia small, hyaline, elliptical to ovoid to globose, succession schizolytic, producing yeast-like growth through budding. Tolerating cycloheximide in culture. Associated with ambrosia beetles.

COMMENTS — Conidiophores and conidia of *Raffaelea* species could fit the concept of *Hyalorhinocladia* H.P. Upadhyay & W.B. Kendr., a common anamorph of *Ophiostoma* species (Gebhardt & Oberwinkler 2005, Massoumi Alamouti et al. 2009, Upadhyay & Kendrick 1975, Zipfel et al. 2006). Past treatments have used the presence of sporodochia to distinguish *Raffaelea* from *Hyalorhinocladia*, but Harrington et al. (2008) proposed that *Raffaelea* species are better distinguished by their symbiotic relationship with ambrosia beetles. That concept is followed here because it appears to distinguish an asexual, monophyletic group within *Ophiostoma* sensu lato (FIG. 2, Gebhardt et al. 2005, Kolarik & Hulcr 2009, Massoumi Alamouti et al. 2009). The generic names *Ambrosiella* and *Dryadomyces* have also been used for symbionts of ambrosia beetles related to *Ophiostoma*. However, the type species of *Ambrosiella* is closely related to *Ceratocystis* rather than *Ophiostoma*, and *Ambrosiella* species within the *Raffaelea* clade are here transferred to *Raffaelea*. *Dryadomyces*, initially separated by its large conidia and prominent scars on the conidiogenous cells (Gebhardt et al. 2005), is within the *Raffaelea* clade, and it is also transferred to *Raffaelea*.

Four new *Raffaelea* species from *Xyleborus glabratus*

Raffaelea subalba T.C. Harr., Aghayeva & Fraedrich, sp. nov.

FIGS. 3B, 4A–B

MYCOBANK 515291, GENBANK EU177443

Coloniae in agaro (MEA) post 10 dies ad 25 C, 25 mm diam, cremae-bubalinae. Conidia blastosporae, globosae vel ovatae, 4.5–5.0 × 3.5–4.0 μm. Socius cum Xyleborus glabratus.

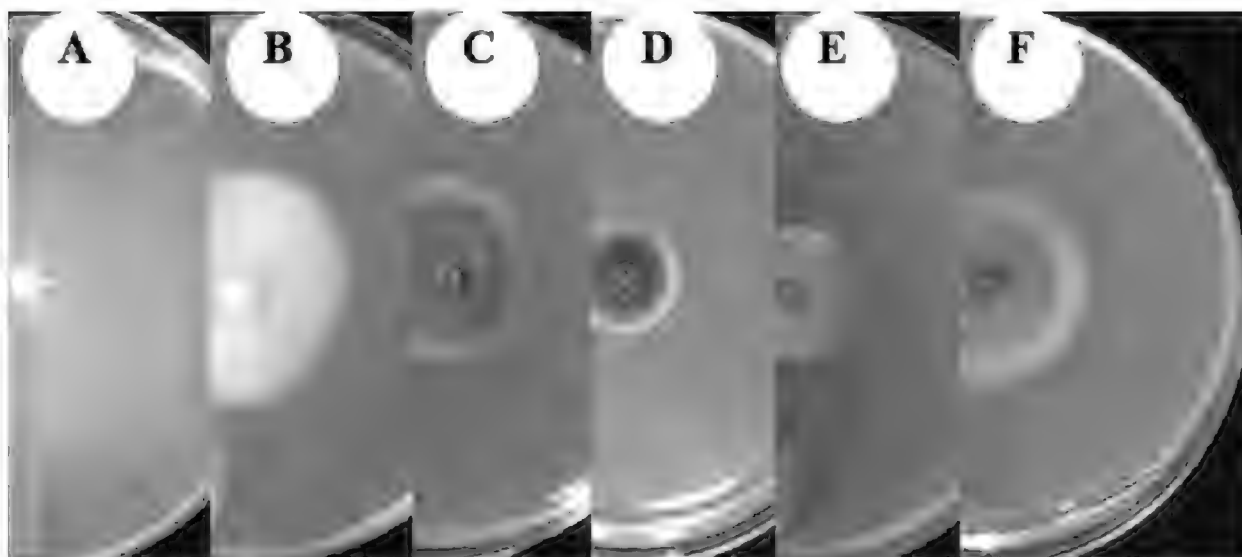


FIG. 3. Colony morphology after 11 days of *Raffaelea* species isolated from *Xyleborus glabratus* on 90 mm diameter plates of malt extract agar. A. *R. lauricola*, B. *R. subalba*, C. *R. ellipticospora*, D. *R. fusca*, E. *R. subfusca*, and F. *R. arxii*. Cultures are from the holotypes except for isolate C2372 of *R. arxii*.

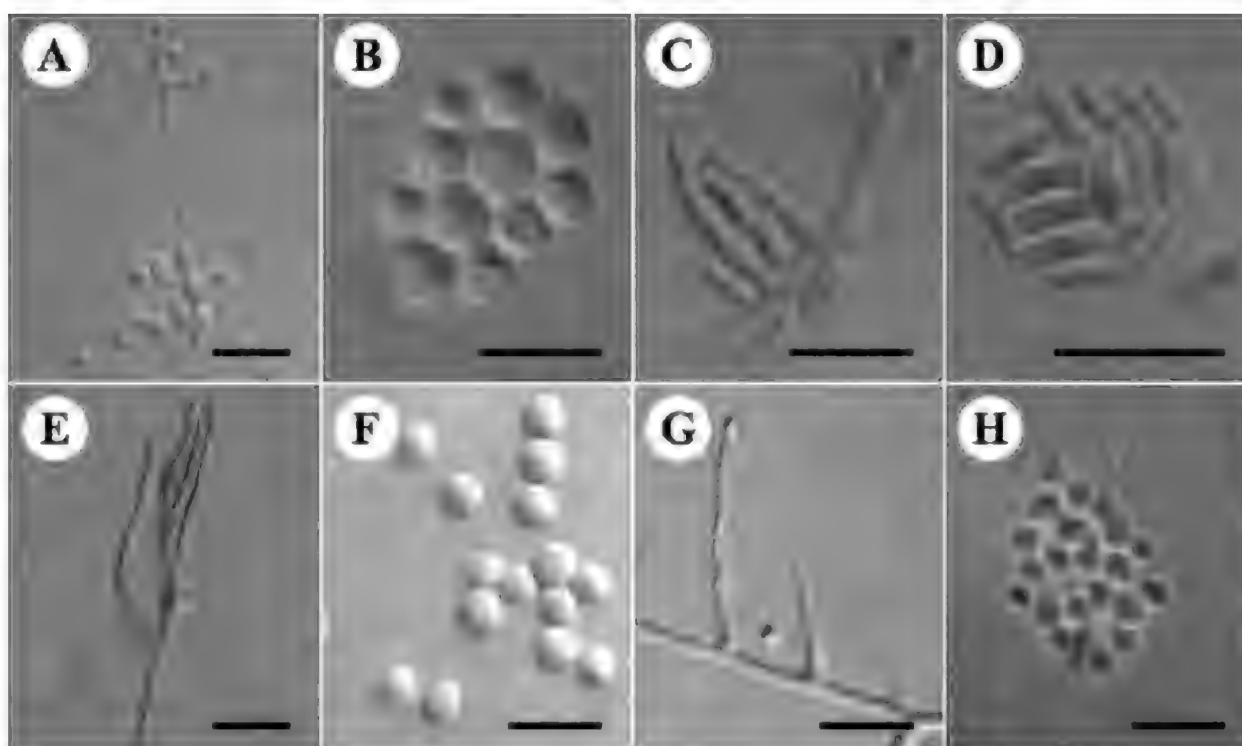


FIG. 4. Conidia and conidiophores of isolates from holotype specimens of four new *Raffaelea* species. A,B. *R. subalba*; C,D. *R. ellipticospora*; E,F. *R. fusca*; G,H. *R. subfusca*. Scale bars = 10 μ m.

HOLOTYPE—UNITED STATES. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*Xyleborus glabratus*, December 2006, S. Fraedrich, BPI 878184, from culture C2401 (= CBS 121568).

COLONIES on malt agar attaining an average diameter of 25 mm in 10 days at 25 C in the dark. Trace growth at 10 C, no growth to 9 mm diameter at 35 C, maximum growth at 25 C. **MYCELIUM** at first smooth, cream-buff (19''d), aerial

hyphae scarce, usually smooth, later mucilaginous, margins of colony even, reverse without distinct color, aroma absent, 2 week old cultures cottony, rugose, buffy brown (17''i), with a yeasty odor. CONIDIOPHORES aseptate, discrete or fasciculate, terminal or arising from side branches, (9.5–)16.0–60(–120) × 1.5–2.0 µm, producing conidia holoblastically without leaving conspicuous scars or annellations. CONIDIA globose to ovate, sometimes pyriform, hyaline, thick-walled, (4.0–)4.5–5.0(–5.5) × (3.0–)3.5–4.0(–4.5) µm. Germinating conidia give rise to budding cells.

CULTURES EXAMINED—UNITED STATES. GEORGIA: JESUP—*Xyleborus glabratus*, October 2006, S. Fraedrich, C2368; SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*X. glabratus*, October 2006, S. Fraedrich, C2388.

COMMENTS — This species produces little pigment on MEA (FIG. 3). It was isolated from *X. glabratus* almost as frequently as *R. lauricola*, which grows at a much faster rate and produces much more mucilage (Harrington et al. 2008). In LSU sequence, *R. subalba* groups with *R. albimanens*, *R. tritirachium*, *R. sulcati*, and a South African isolate misidentified as *R. canadensis* (FIG. 2).

Raffaelea ellipticospora T.C. Harr., Aghayeva & Fraedrich, sp. nov. FIGS. 3C, 4C–D
MYCOBANK 515292, GENBANK EU177446

Coloniae in agar (MEA) post 10 dies ad 25 C, 18 mm diam, brunneolae-olivaceae. Conidia blastosporae, ellipticae vel oblongatae, 5.0–5.5 × 1.0–2.0 µm. Socius cum Xyleborus glabratus.

HOLOTYPE—UNITED STATES. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*Xyleborus glabratus*, December 2006, S. Fraedrich, BPI 878185, from culture C2395 (= CBS 121569).

COLONIES on malt extract agar attaining an average diameter of 18 mm in 10 days at 25 C in the dark. No growth at 10 or 35 C, maximum growth at 25 C. MYCELIUM brown to olivaceous (23m), darker in the center, indistinct white near the edges, edges even, reverse indistinct gray to brownish, aroma absent. Two-week-old cultures gray-brown or dark mouse-gray (15''''k), with yeasty odor, producing sporodochia reduced to discrete fascicles. HYPHAE branched, smooth, hyaline, septate, aerial hyphae scarce. CONIDIOPHORES micronematous, mononematous, erect, cylindrical, fasciculate, hyaline, septate, (17–)30–60(–80) × 1.5–2.0(–2.5) µm. CONIDIA produced singly, ellipsoid to oblong to pyriform, hyaline, (4.0–)5.0–5.5(–6.0) × 1.0–2.0 µm, sometimes larger, 6.5–9.0 × 2.5–4.0 µm.

CULTURES EXAMINED—UNITED STATES. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*Xyleborus glabratus*, June 2006, S. Fraedrich, C2346. HUNTING ISLAND STATE PARK—*X. glabratus*, June 2006, S. Fraedrich, C2350.

COMMENTS — This species is distinguished from other species isolated from *X. glabratus* by its elliptical spores and unique LSU sequence (FIG. 2).

Raffaelea fusca T.C. Harr., Aghayeva & Fraedrich, sp. nov.

FIGS. 3D, 4E–F

MYCOBANK 515293, GENBANK EU177449

Coloniae in agaro (MEA) post 10 dies ad 25 C, 13 mm diam, fuscae-olivaceae. Conidia blastosporae, oblongatae vel ovatae, 4.0–4.5 × 4.0–4.5 μm. Socius cum Xyleborus glabratus.

HOLOTYPE—UNITED STATES. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*Xyleborus glabratus*, December 2006, S. Fraedrich, BPI 878186, from culture C2394 (= CBS 121570).

COLONIES on malt extract agar attaining a diameter of 13 mm in 10 days at 25 C in the dark. Trace to no growth at 10 C and no growth at 35 C, maximum growth at 25 to 30 C. MYCELIUM dark brown to brownish-olive (19''m) in the center, with indistinct white border, edges even, later mucilaginous, reverse gray to brownish, aroma absent. HYPHAE branched, smooth, hyaline, septate, aerial hyphae scarce. Two-week-old cultures develop mat-like mycelia with concentric rings, fuscous black (13'''m) to mouse gray (15''''m) in the center, with yeasty odor, sporodochia reduced to discrete fascicles. CONIDIOPHORES micronematous, mononematous, erect, cylindrical, fasciculate, hyaline, aseptate, scattered, (13.0–)16.0–26.5 × 1.0–1.5(–2.0) μm. CONIDIA produced singly, ovate to obovoid, sometimes pyriform, hyaline, (3.5–)4.0–5.0(–6.5) × (3.5–)4.0–4.5(–5.0) μm.

CULTURES EXAMINED—UNITED STATES. FLORIDA: FORT GEORGE ISLAND—*X. glabratus*, December 2005, S. Fraedrich, C2254. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*X. glabratus*, June 2006, S. Fraedrich, C2336.

COMMENTS — This species produces conidia similar to those of *R. subfusca*, but cultures of *R. fusca* on MEA produce a darker pigmentation (FIG. 3). The LSU sequences of *R. fusca* and *R. subfusca* are also similar, and both are similar to that of *R. ambrosiae* (FIG. 2).

Raffaelea subfusca T.C. Harr., Aghayeva & Fraedrich, sp. nov.

FIGS. 3E, 4G–H

MYCOBANK 515294, GENBANK EU177450

Coloniae in agaro (MEA) post 10 dies ad 25 C, 13 mm diam, pallidae subfuscae-olivaceae. Conidia blastosporae, obovatae vel ovatae, 4.0–5.0 × 3.0–4.0 μm. Socius cum Xyleborus glabratus.

HOLOTYPE—UNITED STATES. SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*Xyleborus glabratus*, June 2006, S. Fraedrich, BPI 878187, from culture C2335 (= CBS 121571).

COLONIES on malt extract agar attaining an average diameter of 13 mm in 10 days at 25 C in the dark. Trace of growth at 10 C and 8 to 12 mm diameter at 35 C, maximum growth at 25–30 C. MYCELIUM light olivaceous (21'''m), darker in the center, indistinct-white near the edges, edges even, reverse indistinct

gray to brownish, aroma absent. Two-week-old cultures grayish-sepia (17''''i) at the edges and mouse-gray (15''''') in the center, wrinkled, with faint concentric circles, producing sporodochia reduced to discrete fascicles, aerial hyphae scarce. HYPHAE branched, smooth, hyaline, septate. CONIDIOPHORES micronematous, mononematous, erect, cylindrical, fasciculate, hyaline, septate, scattered, (5–)12–38(–50) × 1.0–1.5(–2.0) µm. CONIDIA produced singly, ovate to obovoid, sometimes pyriform, (3.5–)4.0–5.0 × (2.5–)3.0–4.0(–5.0) µm.

CULTURES EXAMINED—UNITED STATES. GEORGIA: JESUP—*X. glabratus*, October 2006, S. Fraedrich, C2380; SOUTH CAROLINA: HUNTING ISLAND STATE PARK—*X. glabratus*, June 2006, S. Fraedrich, C2352.

COMMENTS — This species produces conidia similar to those of *R. fusca*, but cultures of *R. subfusca* on MEA produce a lighter pigmentation (FIG. 3), and *R. fusca* fails to grow at 35 C. The LSU sequence of *R. subfusca* and *R. fusca* are also similar (FIG. 2).

Other *Raffaelea* species

Raffaelea albimanens D.B. Scott & J.W. du Toit, Trans. Br. Mycol. Soc. 55: 181. 1970.

COMMENTS — This species is related to *R. sulcati* and *R. tritirachium* based on DNA sequence analyses (FIGS. 1 and 2, Massoumi Alamouti et al. 2009). It was described from *Platypus externedentatus* Fairm. in South Africa (Scott & du Toit 1970).

Raffaelea amasae (Gebhardt) T.C. Harr., **comb. nov.**

MYCOBANK 515295

≡ *Dryadomyces amasae* Gebhardt, Mycolog. Res. 109: 693. 2005.

COMMENTS — The SSU TREES (FIG 1, Gebhardt et al. 2005) and the multigene phylogeny by Massoumi Alamouti et al. (2009) place *R. amasae* within the *Raffaelea* clade near *R. montetyi* and *A. sulphurea*. *R. amasae* is a symbiont of *Amasa concitatus* Wood & Bright (Gebhardt et al. 2005). The somewhat large conidia and prominent scars on the conidiogenous cells at the point of conidial dehiscence are not considered sufficiently distinct to warrant the monotypic genus *Dryadomyces* (Harrington et al. 2008).

Raffaelea ambrosiae Arx & Hennebert, Mycopathol. Mycol. Appl. 25: 310. 1965.

COMMENTS — This type species for the genus *Raffaelea* (Arx & Hennebert 1964) groups near two of the new species from *X. glabratus* in the LSU tree (FIG. 2) and within *Raffaelea* by the multigene phylogeny by Massoumi Alamouti et al. (2009). It has been associated with species of *Platypus* in Europe and the USA (Batra 1968).

Raffaelea arxii D.B. Scott & J.W. du Toit, Trans. Br. Mycol. Soc. 55: 184. 1970.

COMMENTS — The isolate from the holotype (C2218 = CBS 273.70) is near *A. gnathotrichi* in the SSU (FIG. 1), the LSU (FIG. 2), and the multigene trees (Massoumi Alamouti et al. 2009). Isolates with the same LSU sequence were obtained from *X. glabratus*, and *R. arxii* was originally described from an ambrosia beetle of the same genus, *X. torquatus* Eichh., in South Africa.

Raffaelea brunnea (L.R. Batra) T.C. Harr., **comb. nov.**

MYCOBANK 515296

= *Monilia brunnea* Verrall, J. Agr. Res. 66: 142. 1943, nom. illegit. [non J.C. Gilman & E.V. Abbott 1927].

= *Ambrosiella brunnea* L.R. Batra, Mycologia 59: 980. 1968 ("1967").

COMMENTS — This species is near *R. lauricola* based on DNA sequences (FIGS. 1 and 2; Massoumi Alamouti et al. 2009). It was associated with species of *Monarthrum* on *Quercus* in the USA (Batra 1968).

Raffaelea canadensis L.R. Batra, Mycologia 59: 1010. 1968 ("1967").

= *Tuberculariella ambrosiae* A. Funk, Canad. J. Bot. 43: 929. 1965.

= *Ambrosiella sulcati* A. Funk, Canad. J. Bot. 48: 1445. 1970.

COMMENTS — In transferring *Tuberculariella ambrosiae* to *Raffaelea*, Batra (1968) introduced the replacement epithet *canadensis* to avoid creating a homonym of the earlier name *Raffaelea ambrosiae* Arx & Hennebert. Isolate C2233 (= CBS 168.66) from the holotype of *T. ambrosiae* has the same SSU sequence (FIG. 1) as isolate C592 (= CBS 805.70), the holotype of *A. sulcati*, and their LSU sequences are nearly identical (FIG. 2). The multigene phylogeny by Massoumi Alamouti et al. (2009) also shows nearly identical sequences for these two isolates. Descriptions of *A. sulcati* (Funk 1970) and *R. canadensis* (Batra 1968, Funk 1965) are similar, and the two species are considered synonyms. Isolate C2224 from South Africa was deposited in CBS (CBS 326.70) by Scott & du Toit (1970) as *R. canadensis*, but SSU (FIG. 1) and LSU (FIG. 2) sequences place this isolate near *R. sulcati*, and it is considered to be a misidentified isolate. *Raffaelea sulcati* is a species distinct from *A. sulcati* (Funk 1970). *Raffaelea canadensis* has been associated with *Platypus wilsoni* Swaine and *Gnathotrichus sulcatus* Lec. (as *A. sulcati*) in *Pseudotsuga menziesii* (Mirb.) Franco (Funk 1965, 1970).

Raffaelea gnathotrichi (L.R. Batra) T.C. Harr., **comb. nov.**

MYCOBANK 515297

= *Ambrosiella gnathotrichi* L.R. Batra, Mycologia 59: 986. 1968 ("1967").

COMMENTS — This species appears to be related to *R. arxii* by sequence analysis (FIGS. 1 and 2, Massoumi Alamouti et al. 2009). Batra (1968) associated *R. gnathotrichi* with *Gnathotrichus retusus* Lec. on conifers in Colorado.

Raffaelea lauricola T.C. Harr., Fraedrich & Aghayeva, Mycotaxon 104: 401. 2008.

COMMENTS — This lethal pathogen of redbay and other members of the *Lauraceae* is probably from Asia, brought to the USA in mycangia of *X. glabratus* (Harrington et al. 2008).

Raffaelea montetyi M. Morelet, Ann. Soc. Sci. Nat. Arch. Toulon Var 50: 189. 1998.

COMMENTS — This associate of *Platypus cylindrus* Fab. in Europe (Morelet 1998) is related to *A. sulphurea* and *R. amasae* based on SSU analysis (FIG. 1) and a multigene phylogeny (Massoumi Alamouti et al. 2009).

Raffaelea quercivora Kubono & Shin. Ito, Mycoscience 43: 256. 2002.

COMMENTS — At the time of these analyses, no DNA sequence of this symbiont of *Platypus quercivorus* Murayama had been deposited, but a partial LSU sequence is similar to that of *R. montetyi* (Harrington unpublished).

Raffaelea quercus-mongolicae K.H. Kim, Y.J. Choi, & H.D. Shin, Mycotaxon 110: 193. 2009.

COMMENTS — This recently described species is closely related to *R. quercivora*, and the two symbionts are associated with closely related species of *Platypus* (Kim et al. 2009).

Raffaelea santoroi Guerrero, Revt. Invest. Agropec., Sér. 5, 3: 100. 1966.

COMMENTS — A multigene phylogeny (Massoumi Alamouti et al. 2009) placed this species near *R. tritirachium*. It was originally isolated from a bore hole of a *Platypus* sp. in Argentina (Guerrero 1966).

Raffaelea scolytodis M. Kolarik, Mycol. Res. 113: 50. 2009.

COMMENTS — Analysis of SSU and LSU sequences placed *R. scolytodis* among other *Raffaelea* species (Kolarik & Hulcr 2009). It was associated with *Scolytodes unipunctatus* Wood & Bright, the only ambrosia beetle in the genus (Hulcr et al. 2007).

Raffaelea sulcati A. Funk, Canad. J. Bot. 48: 1447. 1970.

COMMENTS — The LSU sequence (FIG. 2) of a culture from the holotype confirms placement of this species in *Raffaelea*. It was associated with *Gnathotrichus sulcatus* in *Pseudotsuga menziesii*. Funk (1970) described *Ambrosiella sulcati* at the same time as *R. sulcati*, distinguishing the former by monilioid chains of conidia, and the latter by sympodial proliferation of conidiogenous cells. *Ambrosiella sulcati* is treated above as a synonym of *R. canadensis*.

***Raffaelea sulphurea* (L.R. Batra) T.C. Harr., comb. nov.**

MYCOBANK 515298

= *Ambrosiella sulphurea* L.R. Batra, Mycologia 59: 992. 1968 ("1967").

COMMENTS — The LSU sequence (FIG. 2) of a culture from the holotype is close to that of *R. montetyi*, and *R. amasae* is also related to these two species based on SSU (FIG. 1) and multigene analyses (Massoumi Alamouti et al. 2009). It was described (Batra 1968) from *X. saxeseni* Ratzeb.

***Raffaelea tritirachium* L.R. Batra, Mycologia 59: 1013. 1968 ("1967").**

COMMENTS — In DNA sequence, *R. tritirachium* appears near *R. albimanens*, *R. sulcati*, *R. santoroi* and one of the new species from *X. glabratus* (FIGS. 1 and 2, Massoumi Alamouti et al. 2009). Batra (1968) considered *R. tritirachium* a contaminant in galleries of *Monarthrum mali* (Fitch), an ambrosia beetle more commonly associated with *R. brunnea*.

Uncertain or excluded species of *Raffaelea*

***Fusarium barbatum* Ellis & Everh., J. Mycol. 4: 45. 1888.**

= *Raffaelea barbata* (Ellis & Everh.) D. Hawksw., Bull. Br. Mus. Nat. Hist. 6: 272. 1979.

COMMENTS — Hawksworth (1979) transferred *F. barbatum* to *Raffaelea* based on production of sporodochia, which were found on the lichen *Usnea barbata*. But the fungus appears to be properly placed among anamorphic *Hypocreales*, i.e., *Fusarium barbatum*.

***Pseudallescheria boydii* (Shear) McGinnis, A.A. Padhye & Ajello, Mycotaxon 14: 97. 1982.**

= *Raffaelea castellanii* (Pinoy) de Hoog, Stud. Mycol. 7: 44. 1974.

COMMENTS — This human pathogen (de Hoog 1974) is properly placed in the *Microascales*.

***Raffaelea hennebertii* D.B. Scott & J.W. du Toit, Trans. Br. Mycol. Soc. 55: 183. 1970.**

COMMENTS — Scott & du Toit (1970) described *R. hennebertii* from *Platypus externedentatus* in South Africa, and their description and illustration are consistent with a species of *Raffaelea*. However, an isolate from the holotype (CBS 272.70) was found to have an SSU sequence near *Melanospora* (*Melanosporales*) by Jones & Blackwell (1998). Further work is needed to be sure the isolate is not a contaminant.

***Raffaelea variabilis* B. Sutton, Antonie van Leeuwenhoek 41: 179. 1975.**

COMMENTS — This species was isolated from the plant *Lannea grandis* (Dennst.) Engl. in Malaysia and was not associated with an ambrosia beetle (Sutton 1975). Thus, it does not ecologically fit the concept of *Raffaelea* presented here.

***Ambrosiella* species**

Ambrosiella Brader ex Arx & Hennebert **emend.** T.C. Harr.

TYPE SPECIES—*Ambrosiella xylebori* Brader ex Arx & Hennebert

Conidiophores single to aggregated in sporodochia, hyaline, unbranched or sparingly branched, one-celled to septate, producing terminal aleurioconidia or chains of conidia from phialides. Sensitive to cycloheximide in culture. Related to species of *Ceratocystis*. Associated with ambrosia beetles.

COMMENTS — The genus is herein restricted to ambrosia beetle symbionts producing conidia from phialides and related to the genus *Ceratocystis*. Five species are recognized in *Ambrosiella* sensu stricto. All are known symbionts of ambrosia beetles and produce conidia from phialides by ring-wall building (Gebhardt et al. 2005). Phylogenetic analyses place four of the species within the genus *Ceratocystis*, though the *Ambrosiella* species do not appear to be a monophyletic group (Harrington 2009, Kolarik & Hulcr 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009). Sexual states for *Ambrosiella* species are not known. The genus name *Thielaviopsis* has been proposed for anamorphs of *Ceratocystis* species (Paulin-Mahady et al. 2002), but *Ambrosiella* is retained here for *Thielaviopsis*-like species associated with ambrosia beetles.

Ambrosiella beaveri Six, De Beer & W.D. Stone, Antonie van Leeuwenhoek 96: 23. 2009.

COMMENTS — This recently-described species is closely related to *A. xylebori* and *A. hartigii* within the *Ceratocystis* group based on LSU and β -tubulin analyses (Six et al. 2009). It was recently described from the ambrosia beetle *Xylosandrus mutilatus* (Blandford) (Six et al. 2009).

Ambrosiella ferruginea L.R. Batra, Mycologia 59: 980. 1968 (“1967”).

= *Monilia ferruginea* Math.-Käarik, Meddel. Statens Skogs-forskningsinstitut 43(4): 57. 1954, non. illegit. [non Pers. 1822]

COMMENTS — Sequence analyses place this associate of *Trypodendron* and *Xyloterus signatus* Fabr. in *Ceratocystis*, but it is not clear whether *A. xylebori* and *A. hartigii* are its nearest relatives (Harrington 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009).

Ambrosiella hartigii L.R. Batra, Mycologia 59: 998. 1968 (“1967”).

COMMENTS — This species is close to *A. xylebori*, the type species of the genus, based on sequences of several genes (Harrington 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009). It has been associated with *Xyleborus dispar* (Fabr.) and *Xylosandrus germanus* (Blandford) (Batra 1968).

***Ambrosiella trypodendri* (L.R. Batra) T.C. Harr., comb. nov.**

MYCOBANK 515299

≡ *Phialophoropsis trypodendri* L.R. Batra, Mycologia 59: 1008. 1968 ("1967").

COMMENTS — Batra's (1968) description of this associate of *Trypodendron scabricollis* (Lec.) states that the conidia are thick-walled phialospores, and his illustrations show spores typical of other *Ambrosiella* species related to *Ceratocystis*, such as *A. hartigii*. No culture or DNA sequence was available for study.

***Ambrosiella xylebori* Brader ex Arx & Hennebert, Mycopath. Mycol. Appl. 25: 314. 1965.**

COMMENTS — This species, the type species for the genus, has been associated with *Xylosandrus compactus* Eichh. and *Corthylus columbianus* (Hopkins) (Arx & Hennebert 1965, Batra 1968). The DNA sequences of *A. xylebori* are close to those of *A. hartigii* and somewhat near *Ceratocystis adiposa* (Harrington 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009).

New combinations in *Hyalorhinocladia* from *Ambrosiella*

Three species of *Ambrosiella* that are fed upon by bark beetles are excluded from *Raffaelea* and *Ambrosiella* by DNA sequence analyses (FIGS. 1 and 2). They form sporodochia, but their simple conidiophores otherwise fit in Upadhyay & Kendrick's (1975) concept of *Hyalorhinocladia* (*Rhinocladia*-like, but lacking pigmentation). *Hyalorhinocladia* species are distinguished from *Sporothrix* by the lack of prominent denticles on the conidiogenous cells (de Hoog 1993).

***Hyalorhinocladia ips* (J.G. Leach, L.W. Orr, & C.M. Chr.) T.C. Harr., comb. nov.**

MYCOBANK 515302

≡ *Tuberculariella ips* J.G. Leach, L.W. Orr, & C.M. Chr., J. Agr. Res. 49: 335. 1934.

≡ *Ambrosiella ips* (J.G. Leach, L.W. Orr, & C.M. Chr.) L.R. Batra, Mycologia 59: 980. 1968 ("1967").

COMMENTS — Sequence analyses place this species among *Ophiostoma* species with *Hyalorhinocladia* anamorphs, especially the species with box-shaped ascospores, such as *O. ips*, *O. bicolor*, and *O. montium* (Figs. 1 and 2, Massoumi Alamouti et al. 2009). *Hyalorhinocladia ips* forms sporodochia in galleries, an adaptation for fungal feeding by insects, but it is fed upon by bark beetles in the genus *Ips*, not by ambrosia beetles (Harrington 2005).

***Hyalorhinocladia macrospora* (Francke-Grosm.) T.C. Harr., comb. nov.**

MYCOBANK 515303

≡ *Trichosporium tingens* var. *macrosporum* Francke-Grosm., Meddel. Statens Skogs-forskningsinstitut 41(6): 27. 1953 ("1952").

≡ *Ambrosiella macrospora* (Francke-Grosm.) L.R. Batra,
Mycologia 59: 980, 1968 ("1967").

COMMENTS — This species was originally described as a variety of *T. tingens*, distinguished by its large conidia. *Hyalorhinocladiella macrospora* has been associated with the mycophagous bark beetle *Ips acuminatus* (Batra 1968, Harrington 2005). The DNA sequences of *H. macrospora* and *H. tingens* are similar (FIGS. 1 and 2, Massoumi Alamouti et al. 2009). Both *H. macrospora* and *H. tingens* produce sporodochia, an adaptation for being fed upon by beetles (Harrington 2005). These species may be related in DNA sequence to *Ophiostoma* species with *Pesotum* anamorphs, but more detailed analyses are needed (FIGS. 1 and 2, Massoumi Alamouti et al. 2009). Batra (1968) reported that the conidia of *H. macrospora* are formed blastically, consistent with *Hyalorhinocladiella*.

Hyalorhinocladiella tingens (Lagerb. & Melin) T.C. Harr., **comb. nov.**

MYCOBANK 515304

≡ *Trichosporium tingens* Lagerb. & Melin, Svenska
Skogsvårdsför. Tidskr. Yr., 1927: 215. 1927.

≡ *Ambrosiella tingens* (Lagerb. & Melin) L.R. Batra, Mycologia 59: 980, 1968 ("1967").

COMMENTS — This species and *H. macrospora*, which was originally described as a variety of *tingens*, may be related in DNA sequence to *Ophiostoma* species with *Pesotum* anamorphs (Figs. 1 and 2, Massoumi Alamouti et al. 2009). It has been associated with mycophagous bark beetles in the genera *Ips* and *Tomicus* in Europe (Batra 1968, Harrington 2005).

Discussion

The asexual, cycloheximide-tolerant symbionts of ambrosia beetles occur in a monophyletic clade within the genus *Ophiostoma*, and *Raffaelea* is proposed as the proper asexual genus for members of this group. The SSU rDNA trees presented by Kolarik & Hulcr (2009) and Gebhardt et al. (2005) both support the monophyletic nature of *Raffaelea*. Our analysis of SSU rDNA does not support the monophyly of *Raffaelea*, but our LSU rDNA analysis does. The multigene analysis of SSU, 5.8S, and LSU rDNA and β -tubulin (Massoumi Alamouti et al. 2009) also infers that the genus *Raffaelea* as proposed here is a monophyletic group. Massoumi Alamouti et al. (2009) found two subclades within *Raffaelea* to have bootstrap support and suggested that these should be recognized as separate genera. However, no phenotypic character distinguishes these two subclades.

Many groups of ascomycetes and basidiomycetes have evolved adaptations for grazing by bark and ambrosia beetles, most notably the aggregation of conidiophores or basidia in dense sporodochia or hymenia within larval

galleries or pupal chambers (Harrington 2005). The *Ophiostomataceae* are believed to have evolved about the time of the rise of conifer bark beetles (Farrell et al. 2001), and *Ophiostoma* species are among the most common associates of conifer bark beetles (Harrington 2005). Ambrosia beetles evolved from bark beetles in at least seven separate events (Farrell et al. 2001), and it is not surprising that most of the symbionts of ambrosia beetles are found in the *Ophiostomataceae*. It is surprising to find, however, that all the asexual symbionts in the *Ophiostoma* clade that are associated with ambrosia beetles may have evolved from a single ancestor. The ancestor of *Raffaelea* may have been uniquely successful in both serving as food for ambrosia beetles (sporodochial phase) and for reproducing in the mycangia of ambrosia beetles (yeast phase). Within *Ceratocystis*, adaptation for ambrosia beetle symbiosis may have arisen at least twice because *A. ferruginea* appears to have arisen as a symbiont separately from the *A. hartigii*, *A. xylebori*, and *A. beaveri* complex (Harrington 2009, Massoumi Alamouti et al. 2009, Paulin-Mahady et al. 2002, Six et al. 2009).

The SSU rDNA analysis by Gebhardt et al. (2005) and our LSU rDNA tree have two groups of *Ophiostoma* species with *Leptographium* anamorphs basal to the *Raffaelea* clade. The combined dataset of Massoumi Alamouti et al. (2009) groups the *Ophiostoma* species with *Leptographium* anamorphs as sister to *Raffaelea*. The SSU rDNA analysis of Kolarik & Hulcr (2009) has *Fragosphaeria purpurea* Shear as closer to the *Raffaelea* species than the *Ophiostoma* species with *Leptographium* anamorphs, but our LSU rDNA analysis has *F. purpurea* and *F. reniformis* (Sacc. & Therry) Malloch & Cain as basal to the clades with *Leptographium* anamorphs and *Raffaelea*. *Raffaelea* species produce conidia blastically, usually without prominent denticles, consistent with the conidiogenous cells of *Leptographium* anamorphs and the anamorph of *F. purpurea* (Shear 1923, Zipfel et al. 2006). Ecologically, *Raffaelea* species appear to be tied more closely to *Ophiostoma* species with *Leptographium* anamorphs, which are mostly associates of conifer bark beetles, than to *Fragosphaeria* species, which are considered to be saprophytes on wood (Malloch & Cain 1970, Shear 1923).

Zipfel et al. (2006) proposed that *Ophiostoma* species with *Leptographium* anamorphs be recognized as a separate genus, *Grosmannia* Goid. Their analysis of combined LSU rDNA and β -tubulin sequences showed good support for *Grosmannia* as a monophyletic group, as did analysis of the combined dataset of Massoumi Alamouti et al. (2009). However, our LSU rDNA analysis and the SSU analyses by Gebhardt et al. (2005) and Kolarik & Hulcr (2009) show two or more distinct clades within *Grosmannia* that do not form a monophyletic group. Inclusion of different taxa, limited taxon sampling, and relatively few protein-coding genes probably are the causes of the discrepancies among

the studies. For instance, the presence or absence of *Fragosphaeria* species appears to affect the topology of the trees. The proposal by Zipfel et al. (2006) to recognize *Grosmannia* may prove to have merit when more taxa and genes are included in the analyses, but the currently available phylogenetic analyses are ambiguous in determining if all *Ophiostoma* species with *Leptographium* anamorphs form a monophyletic group.

Three species of *Ambrosiella* appeared more closely related to other species of *Ophiostoma* than to *Raffaelea* species or *Ophiostoma* species with *Leptographium* anamorphs. These species resemble *Hyalorhinocladia* species, except for their aggregation of conidiophores into sporodochia. Each of these species is fed upon by mycophagous bark beetles (Harrington 2005). Although *H. tingens* and *H. macrospora* appear to be closely related by our LSU rDNA analysis, *H. ips* appears to be more closely related to *O. ips* and *O. montium*, another *Ophiostoma* species fed upon by mycophagous bark beetles (Harrington 2005).

It has generally been accepted that one or a few fungal species are associated with a particular ambrosia beetle species (Batra 1963, Funk 1970), but six species of *Raffaelea* were isolated from *Xyleborus glabratus* in this study. The serial dilution plating technique that we used (Harrington 1992) and the use of cycloheximide in the isolation medium facilitate better recovery of *Raffaelea* species than have other isolation techniques used in the past. As better isolation techniques and DNA sequencing are applied, it is likely to be found that many ambrosia beetles are associated with numerous fungal symbionts.

Reduced morphology of *Raffaelea* species and their highly pleomorphic nature in culture have made it difficult to distinguish species. Some of the six species isolated from *X. glabratus* changed dramatically in culture over time, after storage, and on different media. Thus far, the LSU rDNA sequences appear useful in distinguishing species of *Raffaelea*. Unfortunately, the more variable internal transcribed spacer regions of rDNA are difficult to amplify in some of the *Raffaelea* species, such as *R. lauricola* (Fraedrich et al. 2008). The SSU sequences do not show sufficient variation to distinguish all of the known species of *Raffaelea*.

It is assumed that the six *Raffaelea* species isolated from *X. glabratus* were brought to the USA from Asia with the single introduction of *X. glabratus* to the Savannah, Georgia area (Fraedrich et al. 2008). It is possible that *X. glabratus* has acquired symbionts from other ambrosia beetle species since its arrival in the USA. However, Harrington & Fraedrich (unpublished) have only isolated a true *Ambrosiella* species from *Xylosandrus crassiusculus*, the most common ambrosia beetle competing with *Xyleborus glabratus* in stems of diseased redbay (Fraedrich et al. 2008). If *X. glabratus* brought six *Raffaelea* species with it from

a single introduction of the beetle, then even more species of *Raffaelea* may be associated with this beetle in Asia.

It is also common to find mycelial yeasts, *Pichia* species, and species of *Ophiostoma*, *Pesotum*, *Leptographium*, *Fusarium*, and other filamentous ascomycetes casually associated with ambrosia beetles, usually as secondary colonizers of galleries or superficial contaminants of adults (Batra 1963, 1968). Of the fungi that have been tightly associated with ambrosia beetles, that is, species isolated from mycangia and ambrosial growth in galleries, the majority have been species of *Raffaelea* as recognized here. Considering that a single, introduced population of *X. glabratus* carries six species of *Raffaelea* in its mycangia, that there appears to be some level of specificity, and that there are about 3400 described species of ambrosia beetles (Farrell et al. 2001), there may be many hundreds of species of *Raffaelea* awaiting description.

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Literature cited

- Arx JA von, Hennnebert GL. 1965. Deux champignons ambrosia. Mycopathol. Mycol. Appl. 25: 309-315.
- Batra LR. 1963. Ecology of ambrosia fungi and their dissemination by beetles. Trans. Kansas Acad. Sci. 66: 213-236.
- Batra LR. 1968 ("1967"). Ambrosia fungi: A taxonomic revision and nutritional studies of some species. Mycologia 59: 976-1017.
- Beaver RA. 1989. Insect-fungus relationships in the bark and ambrosia beetles. Pp. 121-143 In: Insect-Fungus Interactions. N Wilding, NM Collins, PM Hammond, JF Webber (eds). Academic Press, London.
- Cassar S, Blackwell M. 1996. Convergent origins of ambrosia fungi. Mycologia 88: 596-601.
- De Hoog GS. 1974. The Genera *Blastobotrys*, *Sporothrix*, *Calcarisporium*, and *Calcarisporiella* gen. nov. Stud. Mycol. 7: 1-84.
- De Hoog GS. 1993. *Sporothrix*-like anamorphs of *Ophiostoma* species and other fungi. Pp. 53-70 In: *Ceratocystis* and *Ophiostoma*. Taxonomy, ecology, and pathogenicity. MJ Wingfield, KA Seifert, JF Webber (eds). American Phytopathological Society Press, St. Paul, Minnesota.
- Farrell BD, Sequeira AS, O'Meara BC, Normark BB, Chung JH, Jordal BH. 2001. The evolution of agriculture in beetles (Curculionidae: Scolytinae and Platypodinae). Evolution 55: 2011-2027.
- Fraedrich SW, Harrington TC, Rabaglia RJ, Ulyshen MD, Mayfield AE, Hanula JL, Eickwort JM, Miller DR. 2008. A fungal symbiont of the redbay ambrosia beetle causes a lethal wilt in redbay and other Lauraceae in the southeastern United States. Plant Dis. 92: 215-224.
- Francke-Grosmann H. 1967. Ectosymbiosis in wood-inhabiting insects. Pp. 142-206 In: SM Henry (ed.). Symbiosis vol. 11. Academic Press. New York.
- Funk A. 1965. The symbiotic fungi of certain ambrosia beetles in British Columbia. Canad. J. Bot. 43: 929-932.

- Funk A. 1970. Fungal symbionts of the ambrosia beetle *Gnathotrichus sulcatus*. *Canad. J. Bot.* 48: 1445–1448.
- Gebhardt H, Oberwinkler F. 2005. Conidial development in selected ambrosial species of the genus *Raffaelea*. *Antonie van Leeuwenhoek* 88: 61–66.
- Gebhardt H, Weiss M, Oberwinkler F. 2005. *Dryadomyces amasae*: a nutritional fungus associated with ambrosia beetles of the genus *Amasa* (Coleoptera: Curculionidae, Scolytinae). *Mycol. Res.* 109: 687–696.
- Guerrero RT. 1966. Una nueva especie de hongo imperfecto asociado con el coleoptero *Platypus sulcatus*. *Revt. Invest. Agropec., Sér. 5*, 3: 97–103.
- Harrington TC. 1981. Cycloheximide sensitivity as a taxonomic character in *Ceratocystis*. *Mycologia* 73: 1123–1129.
- Harrington TC. 1992. *Leptographium*. Pp. 129–133 In: *Methods for Research on Soilborne Phytopathogenic Fungi*. LL Singleton, JD Mihail, CM Rush (eds). American Phytopathological Society Press, St. Paul, Minnesota.
- Harrington TC. 2005. Ecology and evolution of mycophagous bark beetles and their fungal partners. Pp. 257–292 In: *Insect-Fungal Associations: Ecology and Evolution*. FE Vega, M Blackwell (eds). Oxford University Press, Inc. New York.
- Harrington TC. 2009. The genus *Ceratocystis*. Where does the oak wilt fungus fit? *Proceedings of the 2nd National Oak Wilt Symposium.*, DN Appel, RF Billings (eds). Austin, Texas. (in press; on-line version: <http://www.texasoakwilt.org/Professionals/NOWS/conference.html>)
- Harrington TC, Fraedrich SW, Aghayeva DN. 2008. *Raffaelea lauricola*, a new ambrosia beetle symbiont and pathogen on the *Lauraceae*. *Mycotaxon* 104: 399–404.
- Hawksworth DL. 1979. The lichenicolous hyphomycetes. *Bull. Br. Mus. Nat. Hist.* 6: 183–300.
- Hulcr J, Kolarik M, Lawrence LR. 2007. A new record of fungus-beetle symbiosis in *Scolytodes* bark beetles (Scolytinae, Curculionidae, Coleoptera). *Symbiosis* 43: 151–159.
- Jones KG, Blackwell M. 1998. Phylogenetic analysis of ambrosial species in the genus *Raffaelea* based on 18S rDNA sequences. *Mycol. Res.* 102: 661–665.
- Kim KH, Choi YJ, Seo ST, Shin HD. 2009. *Raffaelea quercus-mongolicae* sp. nov. associated with *Platypus koryoensis* on oak in Korea. *Mycotaxon* 110: 189–197.
- Kolarik M, Hulcr J. 2009. Mycobiota associated with the ambrosia beetle *Scolytodes unipunctatus* (Coleoptera: Curculionidae, Scolytinae). *Mycol. Res.* 113: 44–60.
- Kubono T, Ito S. 2002. *Raffaelea quercivora* sp. nov. associated with mass mortality of Japanese oak, and the ambrosia beetle (*Platypus quercivorus*). *Mycoscience* 43: 255–260.
- Malloch D, Cain RF. 1970. Five new genera in the new family Pseudoeurotiaceae. *Canad. J. Bot.* 48: 1815–1825.
- Massoumi Alamouti S, Tsui CKM, Breuil C. 2009. Multigene phylogeny of filamentous ambrosia fungi associated with ambrosia and bark beetles. *Mycol. Res.* 113: 822–835.
- Morelet M. 1998. Une espèce nouvelle de *Raffaelea*, isolée de *Platypus cylindrus*, coléoptère xylomycetétophage des chênes. *Annal. Soc. Sci. Nat. Arch. de Toulon et Var* 50: 185–193.
- Paulin-Mahady AE, Harrington TC, McNew D. 2002. Phylogenetic and taxonomic evaluation of *Chalara*, *Chalaropsis*, and *Thielaviopsis* anamorphs associated with *Ceratocystis*. *Mycologia* 94: 62–72.
- Rayner RW. 1970. *A Mycological Colour Chart*. Commonwealth Mycological Institute, Kew, Surrey.
- Rollins F, Jones KG, Krokene P, Solheim H, Blackwell M. 2001. Phylogeny of asexual fungi associated with bark and ambrosia beetles. *Mycologia* 93: 991–996.
- Scott DB, du Toit JW. 1970. Three new *Raffaelea* species. *Trans. Br. Mycol. Soc.* 55: 181–186.

- Shear CL. 1923. Life histories and undescribed genera and species of fungi. *Mycologia* 15: 120–131.
- Six DL. 2003. Bark beetle-fungus symbioses. Pp. 99–116 In: K Bourtzis, TA Miller (eds). *Insect Symbiosis*. CRC Press, New York.
- Six DL, Stone WD, de Beer ZW, Woolfolk SW. 2009. *Ambrosiella beaveri*, sp. nov., associated with an exotic ambrosia beetle, *Xylosandrus mutilatus* (Coleoptera: Curculionidae, Scolytinae), in Mississippi, USA. *Antonie van Leeuwenhoek* 96: 17–29.
- Sutton BC. 1975. Two undescribed hyphomycetes from Malaysia. *Antonie van Leeuwenhoek* 41: 179–184.
- Upadhyay HP, Kendrick WB. 1975. Prodrum for a revision of *Ceratocystis* (*Microascales*, *Ascomycetes*) and its conidial states. *Mycologia* 67: 798–805.
- Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *J. Bacteriol.* 172: 4238–4246.
- White TJ, Bruns T, Lee S, Taylor J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pp. 315–322 In: MA Innis, DH Gelfand, JJ Sninsky, TJ White (eds). *PCR Protocols: a Sequencing Guide to Methods and Applications*. Academic Press, San Diego.
- Wood SL, Bright DE. 1992. A catalog of Scolytidae and Platypodidae (Coleoptera), Part 2: Taxonomic index, volumes A and B. *Great Basin Naturalist Memoirs* No. 13.
- Zipfel RD, de Beer ZW, Jacobs K, Wingfield BD, Wingfield MJ. 2006. Multi-gene phylogenies define *Ceratocystiopsis* and *Grosmannia* distinct from *Ophiostoma*. *Stud. Mycol.* 55: 75–97.

***Megacollybia virosa*, a new species with toxic basidiomata from India**

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Abstract — *Megacollybia virosa* sp. nov. is described and illustrated from Kerala State, India. Basidiomata of this species when eaten produce severe gastrointestinal upset.

Key words — *Agaricales*, *Basidiomycota*, poisonous mushroom, taxonomy

Introduction

The genus *Megacollybia* Kotl. & Pouzar (*Marasmiaceae*, *Agaricales*, *Basidiomycota*) was originally proposed for *M. platyphylla* (Pers.) Kotl. & Pouzar, a species that had been placed in several genera such as *Collybia* (Fr.) Staude, *Clitocybula* (Singer) Singer ex Métrod, *Hydropus* Kühner ex Singer, *Oudemansiella* Speg., and *Tricholomopsis* Singer. Until recently, *Megacollybia* had been treated as monotypic. ITS-based phylogenetic reconstruction, combined with macro- and micromorphological analyses, however, resulted in the recognition of six additional species and the transfer of *Tricholomopsis fallax* A.H. Sm. to *Megacollybia* (Hughes et al. 2007). Collybioid to clitocyboid or tricholomatoid basidiomata; fibrillose and finely radially streaked or rarely minutely scabrous to minutely squamulose pileal surface; white pileal trama often showing greatly inflated tramal hyphae; adnexed to adnate lamellae usually with a decurrent tooth; thin-walled, ellipsoid to somewhat ovate, inamyloid basidiospores that fit within a narrow range of dimensions, 6–10 × 5–7 µm; basidia that fit generally within 35–43 × 8–11 µm; somewhat regular lamellar trama that exhibits large areas of intricately interwoven hyphae;

plentiful cheilocystidia; and conspicuous clamp connections are characteristics of this genus (Hughes et al. 2007). The genus appears to be predominantly North Temperate in distribution (Hughes et al. 2007).

While studying the agarics of Kerala State, India, we came across an agaric that fits well in the current circumscription of *Megacollybia*. It seems to be quite distinct from all the other eight species so far described in that genus. Remarkably, the basidiomata of this species when eaten produce severe gastrointestinal upset. It is described here as a new species along with an account of the poisoning caused by it.

Materials and methods

Conventional morphology-based taxonomic methods were employed for this study. Microscopic observations were made on material stained with 1% aqueous solutions of phloxine and Congo red and mounted in 3% aqueous KOH. Melzer's reagent was used to observe whether the spores were amyloid. Twenty basidiospores per specimen were measured. Colour codes refer to Kornerup & Wanscher (1978). All examined collections cited are deposited at the Herbarium of the University of Tennessee (TENN).

Taxonomic account

Megacollybia virosa Manim. & K.B. Vrinda, sp. nov.

FIGURE 1, 2 A–E

MYCOBANK MB515520

Basidioma clitocyboidea, robusta. Pileus 45–100 mm latus, convexus vel plano-convexus, brunneus, griseo-brunneus vel atro griseus, pruinosis vel granulatus. Lamellae adnatae vel decurrentes, confertae, albae. Stipes 20–75 × 5–23 mm, albus, squamuloso griseo-brunneo punctatus. Odore ingrato. Sporae 6.5–11(–12) × 5–7 µm, subglobosae vel ellipsoideae, inamyloidae. Basidia 23–56 × 7.5–11 µm, clavata, 4-sporigera. Acies lamellarum steriles. Cheilocystidia 20–63 × 5.5–9 µm, cylindracea, cylindrico-clavata vel ventricoso-rostrata, ad apicem subcapitata et exsudato glutinoso instructa, hyalina. Pleurocystidia nulla. Trama hymenophoralis subregularis, hyalina. Epicutis pilei disrupta, ex hyphis repentibus et hyphis erectis composita. Hyphae omnes fibulatae.

HOLOTYPE — INDIA, KERALA STATE, Calicut District, PUTHIYANGADI: 12 June. 2006, T.K. Arun Kumar AK395 (TENN63392).

ETYMOLOGY: *virosa* (Latin), poisonous

BASIDIOMATA medium-sized, fleshy, clitocyboid. **PILEUS** 45–100 mm diam., convex, becoming broadly convex; surface light brown (6D5), brown (6E4), greyish brown (7E3), or dark grey (7F8), slightly darker at the centre, pruinose to somewhat granular to naked eye, with fine appressed scales under a lens, dry; margin inrolled when very young, becoming incurved and finally becoming straight, initially entire, becoming fissile with age. **LAMELLAE** adnate to decurrent, moderately crowded, with lamellulae in four to eight tiers, up to



FIGURE 1. Basidiomata of *Megacollybia virosa*.

9 mm thick, whitish to yellowish white (1A2); edge smooth to finely fimbriate under a lens. STIPE 20–75 × 5–23 mm, central or at times slightly excentric, terete to slightly compressed, almost equal with a dilated apex, solid, with white basal mycelium; surface dull white with fine, light brown (6D5), greyish brown (7E3) or dark grey granular squamules that are concentrated towards the base and disappearing easily when handled. CONTEXT up to 20 mm thick, white. ODOUR strong and unpleasant. SPORE-PRINT white.

BASIDIOSPORES 6.5–11(–12) × 5–7 μm , subglobose to ellipsoid, thin-walled, smooth, with refractive guttules, inamyloid. BASIDIA 23–56 × 7.5–11 μm , cylindrico-clavate to clavate, thin-walled, hyaline, with granular contents, 4-spored; sterigmata up to 5 μm long. LAMELLA-EDGE sterile. CHEILOCYSTIDIA abundant, 20–63 × 5.5–9 μm , clavate, cylindrico-clavate, or ventricose, majority with a small capitellum on a slender neck up to 35 μm long, often septate, thin-walled, hyaline to pale yellowish, apex sometimes covered with glutinous exudates. PLEUROCYSTIDIA absent. LAMELLAR TRAMA regular to

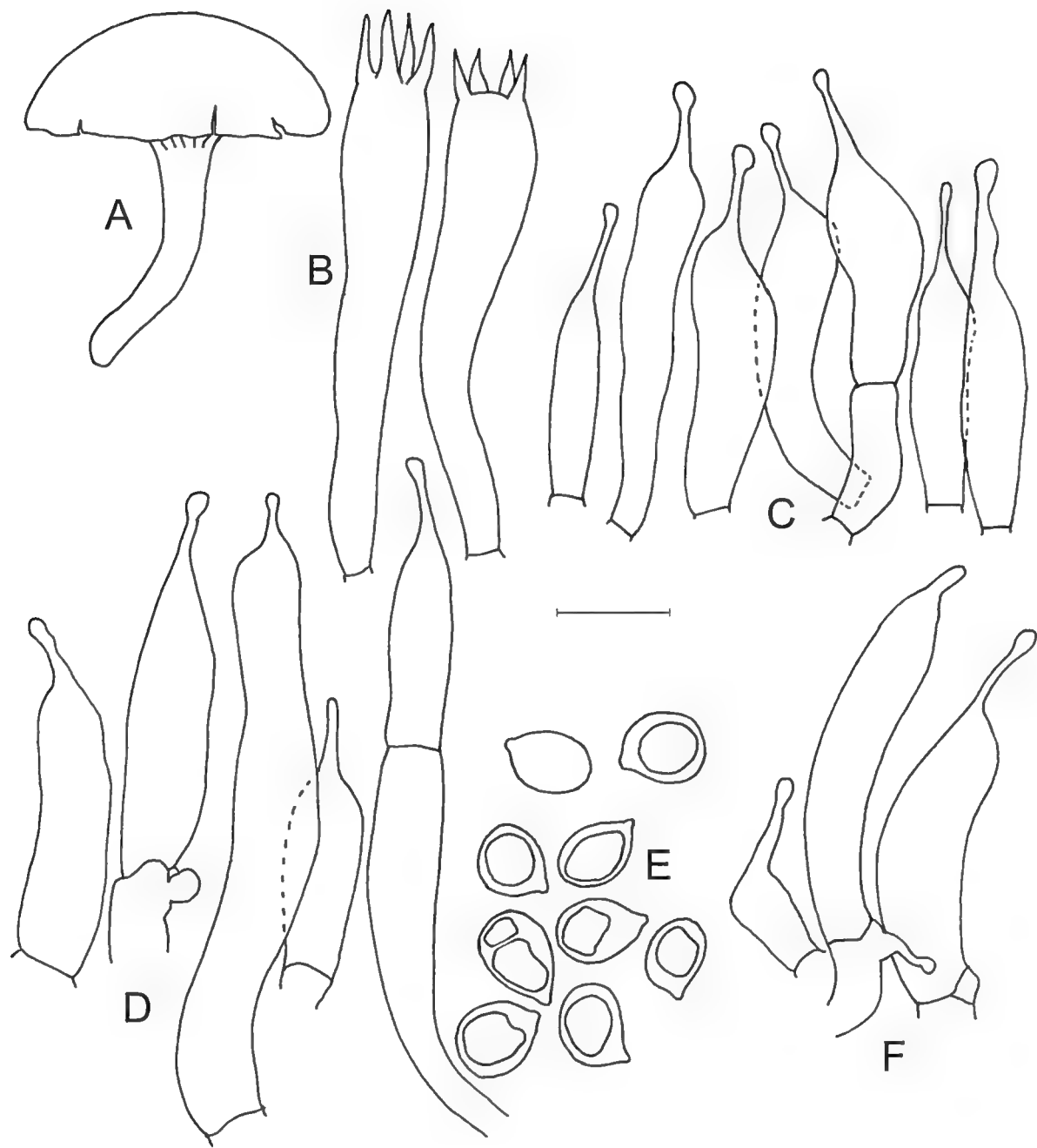


FIGURE 2, A–F: *Megacollybia virosa*.
A, basidioma; B, basidia; C, cheilocystidia; D, terminal elements of pileipellis hyphae;
E, spores; F, terminal elements of stipitipellis hyphae;
scale bar: 2 cm for basidioma and 10 μm for microscopic structures.

subregular; hyphae 3–15 μm wide, hyaline to pale yellowish, thin-walled, inamyloid. PILEAL TRAMA interwoven; hyphae 2–20 μm wide, slightly inflated, hyaline to pale yellowish, thin-walled. PILEIPELLIS mostly a cutis of highly interwoven agglutinated hyphae, occasionally disrupted with trichodermal patches; hyphae 3–10 μm wide, thin- to slightly thick-walled, often with a greyish brown plasmatic pigment; terminal elements cystidioid, 23–85 \times 3–10

µm, similar to cheilocystidia in all aspects, often with a greyish brown plasmatic pigment. STIPITIPPELLIS a highly disrupted and irregular cutis with agglutinated trichodermal patches of ascending to erect hyphal elements; hyphae 2–21 µm wide, thin- to slightly thick-walled, with grey to dark greyish plasmatic and membrane pigment; terminal elements cystidioid, similar to cheilocystidia in all aspects. CLAMP-CONNECTIONS frequent on all hyphae.

HABITAT: On soil or on mud walls, often associated with roots of coconut trees, solitary or in caespitose clusters.

ADDITIONAL COLLECTIONS EXAMINED — INDIA, KERALA STATE, Calicut District, PUTHIYANGADI: 31 July 2005, T.K. Arun Kumar AK373 (TENN63390); 10 August 2005, T.K. Arun Kumar AK378 (TENN63393); 21 June 2006, T.K. Arun Kumar AK397 (TENN63391); Thiruvananthapuram District, PLAMOOD: 30 May 1998, C.K. Pradeep 4310 (TENN63385); VIZHINJAM: 11 December 2000, C.K. Pradeep 5249 (TENN63386); 23 May 2002, C.K. Pradeep 5526 (TENN63387); MUTTADA: 9 July 2006, K.B. Vrinda 9804 (TENN63388); 28 August 2006, K.B. Vrinda 9938 (TENN63389).

DISCUSSION: Although the genus *Megacollybia* lacks any unique and spectacular morphological feature that helps in its recognition, based on phylogenetic reconstruction and macro- and micromorphological analyses, Hughes et al. (2007) have identified a set of morphological features common to all the species hitherto recognised in that genus. As this new species has most of those characters (some of which are listed earlier), we assign it to *Megacollybia*. This species is characterised by robust, clitocyboid basidiomata; finely granular, grey-tinted pileus; adnate to decurrent lamellae; white pileal context; thin-walled, ellipsoid to subglobose, inamyloid spores; plentiful cheilocystidia of a unique morphology; cystidioid terminal elements of hyphae of pileipellis; and conspicuous clamp connections. It can be distinguished from all other species of *Megacollybia* owing to its unique cheilocystidia and the terminal elements of the pileipellis.

This species had been collected by the present authors from different parts of Kerala on several occasions in the past but it remained unidentified. Remarkably, in 2006, the last two authors were alerted by a report of a case of mushroom poisoning in a local newspaper. According to this report, a 4-member family got admitted to a local hospital owing to severe gastrointestinal upset after cooking and eating a locally collected mushroom that they considered edible. When the family was discharged from the hospital, with their help, these authors collected basidiomata of the same mushroom from the same locality from where the family had originally collected it. Subsequent studies revealed that this poisonous mushroom was conspecific with the previously collected unidentified species. It seems that this species is rather widely distributed in Kerala State. The robust grey-tinted basidiomata of this species seems to have the capacity to mislead uninitiated people to mistake them for some traditionally eaten species of *Tricholoma* (Fr.) Staude or *Termitomyces* R. Heim.

It seems a streak of toxic nature runs in the genus *Megacollybia*. Basidiomata of *M. platyphylla* are known to cause gastrointestinal irritation (Goos & Shoop 1980, Goos 1984, Spoerke 1994, Barceloux 2008).

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Literature cited

- Barceloux DG. 2008. Medical toxicology of natural substances: foods, fungi, medicinal herbs, plants, and venomous animals. New Jersey, John Wiley and Sons.
- Goos RD. 1984. Another case of mushroom poisoning involving *Tricholomopsis platyphylla*. *Mycologia* 76: 350–351.
- Goos RD, Shoop CR. 1980. A case of mushroom poisoning caused by *Tricholomopsis platyphylla*. *Mycologia* 72: 433–435.
- Hughes KW, Petersen RH, Mata JL, Psurtseva, NV, Kovalenko AE, Morozova OV, Lickey EB, Cifuentes Blanco J, Lewis DP, Nagasawa E, Halling RE, Takehashi S, Aime MC, Bau T, Henkel T. 2007. *Megacollybia* (*Agaricales*). Reports of the Tottori Mycological Institute. 45: 1–57.
- Kornerup A, Wanscher JH. 1978. Methuen handbook of colour, 3rd edn., London, Methuen.
- Spoerke DG. 1994. Gastrointestinal irritant mushrooms. In Spoerke DG, Rumack BH. (Ed.), Handbook of mushroom poisoning: diagnosis and treatment, Boca Raton, CRC Press, pp. 347–366.

Marasmioid and gymnopoid fungi of the Republic of Korea. 3. Two new taxa of *Marasmius* sect. *Sicci* with caulocystidia and/or setae

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Abstract — Two new species of *Marasmius* sect. *Sicci* are described. *Marasmius orientalis*, which is characterized by having a pileipellis with well-developed setoid broom cells and setae, caulosetae present, belongs to series *Spinulosi*. *Marasmius strobiluriformis* has dimorphic cheilocystidia and cylindrical to subfusoid caulocystidia and belongs to ser. *Atrorubentes*. The macro- and microscopic descriptions with discussion on similar taxa are given, and their taxonomic position is supported through DNA analyses.

Key words — euagarics, *Marasmiaceae*, taxonomy, nomenclature, LSU, ITS

Introduction

This paper is a part of a series dealing with the marasmioid and gymnopoid fungi of the Republic of Korea studied within a joint project (Antonín et al. 2009, 2010). During joint field excursions, many collections of those fungi were collected, including several new taxa. Two of them, belonging to section *Sicci* with well-developed setae and/or caulocystidia (series *Spinulosi* and ser. *Atrorubentes*), are described here.

Material and methods

Macroscopic descriptions of collected specimens are based on fresh basidiocarps and photos made by the second author. Microscopic features are described from dried

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material mounted in H₂O, KOH, Melzer's reagent and Congo Red using an Olympus BX-50 light microscope with a magnification of 1000×. For basidiospores, the factors E (quotient of length and width in any one spore) and Q (mean of E-values) are used. For lamellae, L means number of entire lamellae and l means number of lamellulae between each pair of entire lamellae. Authors of fungal names are cited according to the International Plant Names Index Authors website (<http://www.ipni.org/ipni/authorsearchpage.do>). Herbarium specimens are preserved in the herbarium of the Moravian Museum, Brno, Czech Republic (BRNM).

Genomic DNA was extracted using a small piece (3–4 mm³) of the dried basidiocarp. The DNA extraction was made according to Lee & Taylor (1990). PCR amplification of nLSU rDNA region was made according to the modified method by Moncalvo et al. (2000). PCR primer LR0R and LR7 were used for the selective amplification of nLSU rDNA region. PCR amplification of ITS rDNA region was performed according to the modified method described by Douanla-Meli & Langer (2008). Forward primer ITS1-F and reverse primer ITS4-B were used for the selective amplification of ITS rDNA region. Purified DNAs were directly sequenced on an ABI Prism TM 377 DNA Automatic Sequencer (Applied Biosystems, Foster City, CA, USA) using BigDye™ cycle sequencing kit, version 3.1 (Applied Biosystems). Primers identical with amplification for ITS rDNA whereas LR0R, LR7 and additional internal primer LR3 for LSU rDNA were used.

Sequences were edited with the DNASTAR software (Lasergene, Madison, Wis.). An alignment of the sequences was performed using the CLUSTAL X (Thompson et al. 1997). Phylogenetic trees were obtained from the data using Bayesian modelling (Geyer 1991; MRBAYES, version 3.0b4, Ronquist & Huelsenbeck 2003). For a given data set, the general time reversible (GTR) model was employed with gamma-distributed substitution rates. Markov chains were run for 2,000,000 generations, saving a tree every 100th generation. Among these, the first 1000 trees were discarded as burn-in phase of each analysis. MRBAYES was used to compute a 50% majority rule consensus of the remaining trees to obtain estimates for the posterior probabilities (PPs) of the groups. The type species of the genus *Marasmius*, *M. rotula* (Scop. : Fr.) Fr. (sect. *Marasmius*), was selected as the outgroup.

Taxonomy

Marasmius orientalis Antonín, R. Ryoo & H.D. Shin, **sp. nov.**

FIG. 1

MYCOBANK MB 515673

NCBI ACCESSION NUMBERS: BRNM 714913 [GU266262 (ITS), GU266269 (LSU)]

Pileo usque 29 mm lato, conico, campanulato, obtuso, striato-sulcato, marginem crenulato, albido vel cremeo, centro brunneo. Lamellis distantibus, cremeis. Stipite ca. 60 × 1.5 mm, cylindraceo, subtiliter pubescente, ad apicem albido vel cremeo, ad basin (aurantiaco-)brunneo. Basidiosporis 9.0–10.5 × 4.5–6.0 µm, ellipsoideis, ellipsoideo-fusiformibus. Cheilocystidiis 16–28 × 5.0–9.0 µm, clavatis, (sub)cylindraceis, subvesiculososis, saepe irregularibus, tenuitunicatis. Pleurocystidiis 40–45 × 7.0–10 µm, fusiformibus, cylindraceis, rostratis, tenuitunicatis. Pileipellis hymeniformis, e cellulis (15–)24–40 × (8.0–)10–12 µm, clavatis, pyriformibus vel subcylindraceis, laevibus; pileoetis et cellulis similibus cellularum hymenidermatis Marasmii sicci, crassitunicatis praesentis. Cauloetis 35–70 × 6.0–9.0(–12) µm, fusiformibus, lageniformibus, crassitunicatis luteo-brunneis. Hyphis fibulatis, in stipite et trama dextrinoideis.

HOLOTYPE: *Republic of Korea, Seoul, park nationalis Bukhansan, apud rivi Jeongreung, 17. VII. 2008, leg. R. Ryoo KG 255 (holotypus in herbario BRNM 714913 asservatur).*

ETYMOLOGY: from the Latin *oriens* = east

BASIDIOCARPS single. PILEUS up to c. 25 mm broad, broadly conical or high-campanulate with obtuse centre and inflexed crenulate margin, striate-sulcate, slightly tomentose, off-white to cream with brown centre. LAMELLAE distant, $L = c. 18, l = 1$, emarginate and with small tooth, cream with concolorous edge. STIPE c. 60×1.5 mm, cylindrical, minutely pubescent, non-insititious, white or cream above, (orange-)brown towards base. (Description according to one photo and dry basidiocarp).

BASIDIOSPORES $9.0\text{--}10.5 \times 4.5\text{--}6.0$ μm , average = 9.8×5.2 μm , $E = 1.7\text{--}2.1$, $Q = 1.9$, ellipsoid, ellipsoid-fusoid, ellipsoid-lacrimoid, smooth, hyaline, non-dextrinoid, both thin-walled and slightly thick-walled. BASIDIA not found. BASIDIOLES up to $45 \times 4.0\text{--}8.0$ μm , cylindrical, clavate. CHEILOCYSTIDIA $16\text{--}28 \times 5.0\text{--}9.0$ μm , clavate, (sub)vesiculose, subcylindrical, often irregular, smooth, sometimes with apical projections, thin-walled. PLEUROCYSTIDIA $40\text{--}45 \times 7.0\text{--}10$ μm , fusoid or subcylindrical, rostrate, refractive, thin-walled, sometimes originating in subhymenium and not or only slightly projecting beyond hymenium. TRAMA HYPHAE \pm cylindrical, thin- to slightly thick-walled, smooth or minutely incrustated, hyaline, dextrinoid, up to 12 μm wide. PILEIPELLIS a hymeniderm composed of $(15\text{--})24\text{--}40 \times (8.0\text{--})10\text{--}12$ μm , clavate, pyriform, subcylindrical, smooth, thin-walled with often slightly thick-walled central part, hyaline to yellow-brown in KOH; mixed with setoid broom cells and setae, cylindrical to clavate, or fusoid, subulate or sublageniform, thick-walled, weakly dextrinoid, yellow-brown in KOH, with up to 35×3.0 μm , obtuse to subacute projections. STIPITPELLIS a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0 μm wide hyphae with yellow-brown walls in KOH. CAULOSETAE $35\text{--}70 \times 6.0\text{--}9.0(-12)$ μm , fusoid, lageniform, subulate, often branched, thick-walled (walls up to 1.0 μm), obtuse to acute, weakly dextrinoid, with yellow-brown walls in KOH. CLAMP CONNECTIONS present in all tissues.

HABITAT — On detritus of broadleaf trees.

REMARKS — *Marasmius orientalis* is characterized by having a broadly conical, striate-sulcate, off-white to cream coloured pileus with a brown centre, rather small basidiospores, mostly smooth cheilocystidia, well-developed fusoid or subcylindrical pleurocystidia, pileipellis of smooth cells with well-developed setoid broom cells and setae and present cauloseae. Having well-developed setae, it belongs to ser. *Spinulosi* (Cl  men  on) Desjardin.

Marasmius torquescens Qu  l., widespread in Europe, is a very similar species. It differs only by a never sulcate and high-campanulate pileus, slightly different cheilocystidia, and smaller pleurocystidia (Anton  n & Noordeloos

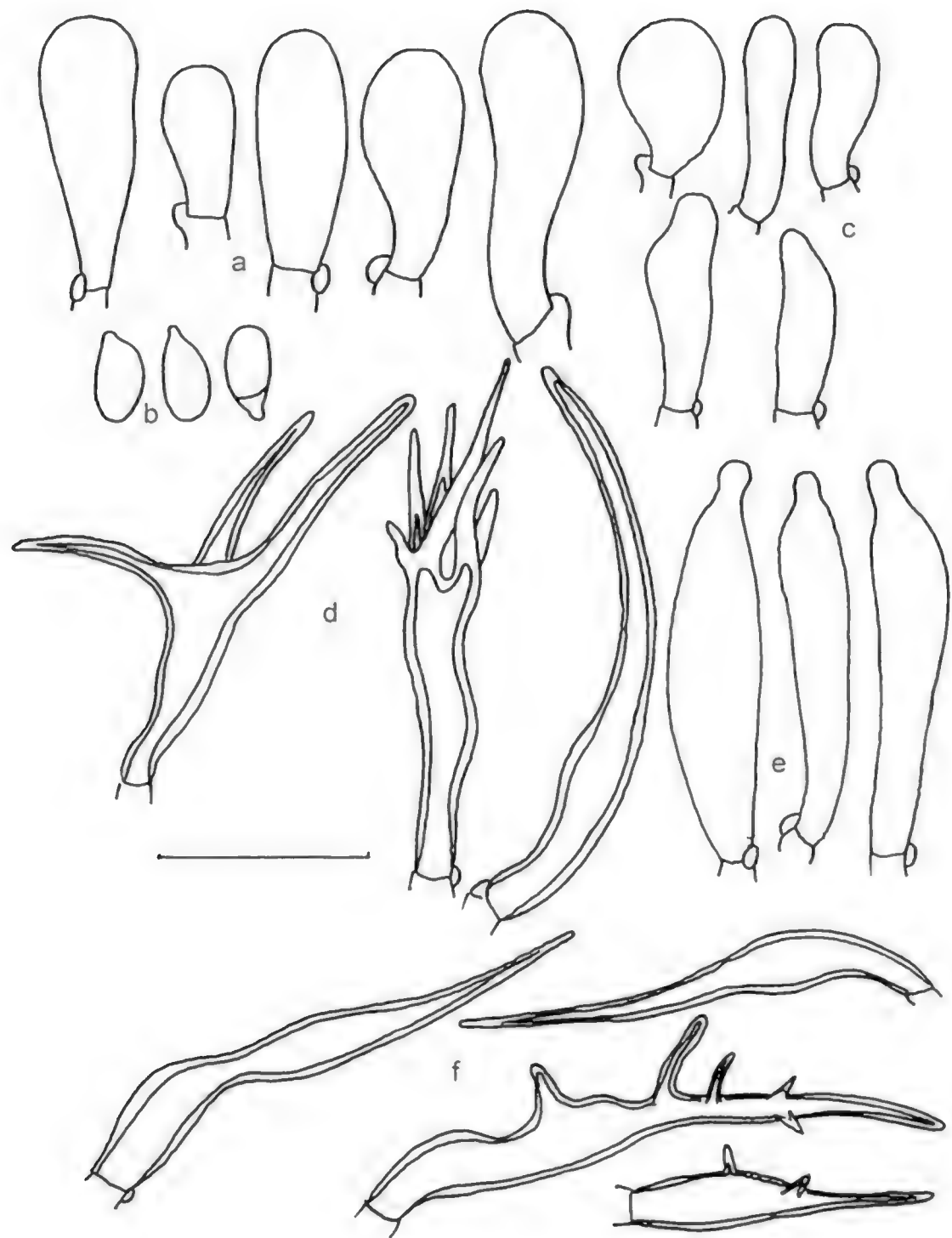


FIG. 1. *Marasmius orientalis*.

a) pileipellis cells, b) basidiospores, c) cheilocystidia,
d) pileus setoid broom cells and pileosetae, e) pleurocystidia, f) caulosetae.
Scale bar = 20 μ m.

2010). *Marasmius torquescens* and *M. orientalis* significantly differ in DNA sequences. Macroscopically similar *M. delectans* Morgan and *M. cohaerens* var. *lachnophyllus* (Berk.) Gilliam differ especially by having hymenial setae and \pm different pileipellis structure (Gilliam 1976). *Marasmius mokfaensis* Wannathes et al. has distinctly larger basidiocarps, larger basidiospores (27–33 x 5–6 μ m), and absent pleurocystidia and setae (Wannathes et al. 2009).

Marasmius strobiluriformis Antonín, R. Ryoo & H.D. Shin, sp. nov.

FIG. 2

MYCOBANK MB 515674

NCBI ACCESSION NUMBERS: BRNM 714914 [GU266263 (ITS), GU266270 (LSU)];

BRNM 714915 [GU266264 (ITS), GU266271 (LSU)]

Pileo usque ca. 12 mm lato, convexo-hemisphaerico vel plano-convexo, obtuso, albo. Lamellis albis. Stipite ca. 40 × 1 mm, cylindraco, subtiliter pubescente, apicem albido, ad basin aurantiaco-brunneo. Basidiosporis (9.0–)10–14 × 4.0–5.5 µm, fusiformibus, raro ellipsoideo-fusiformibus. Cheilocystidiis (1) e cellulis similibus cellulis typo Marasmii sicci, 13–23 × 6.0–13 µm, clavatis, pyriformibus, subvesiculososis, subcylindracois, tenuitunicatis, (2) 14–32 × 4.5–10(–14) µm, fusiformibus, cylindracois, clavatis, vesiculososis, glabris vel cum projectionibus apicalibus, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii sicci, 10–18 × 6.0–9.0 µm, clavatis, pyriformibus, subfusiformibus vel subcylindracois, tenuitunicatis. Caulocystidiis 25–55 × 5.0–8.0 µm, cylindracois vel subfusiformibus, leviter irregularibus, leviter crassitunicatis. Hyphis fibulatis, in stipite et trama dextrinoideis.

HOLOTYPE: Republic of Korea, Chuncheon, Dongsan-myon, Bongmyong-ri, 20. VIII. 2007 leg. R. Ryoo KG 142 (*holotypus in herbario BRNM 714914 asservatur*).

ETYMOLOGY: basidiocarps similar to the genus *Strobilurus*

BASIDIOCARPS single. PILEUS up to c. 12 mm broad, convex-hemispherical, then plano-convex with obtuse centre and involute, then inflexed margin, smooth, slightly tomentose, white. LAMELLAE moderately close, L = 15–17, l = 3, emarginate, white with concolorous, finely pubescent edge. STIPE c. 40 × 1 mm, cylindrical, minutely pubescent, non-insititious, white above, orange-brown towards base.

BASIDIOSPORES (9.5–)10–14(–15) × 4.0–5.5 µm, average = 12 × 4.6 µm, E = 2.0–3.3, Q = 2.3–3.0, fusoid, less frequently ellipsoid-fusoid, smooth, hyaline, non-dextrinoid, thin-walled. BASIDIA not found. BASIDIOLES up to 35 × 3.0–9.0 µm, cylindrical, subfusoid, clavate. CHEILOCYSTIDIA of two types, (1) in the form of broom cells of the Siccus-type, 13–23 × 6.0–13 µm, clavate, pyriform, subvesiculose, subcylindrical, thin-walled; projections up to 25, digitate, nodulose, obtuse to (sub)acute, thin to slightly thick-walled, up to 7.0 × 1.0 µm, and (2) fusoid, cylindrical, clavate, vesiculose, 14–32 × 4.5–10(–14) µm, smooth or with ± large apical projections, not refractive, thin-walled. PLEUROCISTIDIA absent. TRAMA HYPHAE ± cylindrical, thin- to slightly thick-walled, hyaline, dextrinoid, up to 20 µm wide. PILEIPELLIS a hymeniderm composed of broom cells of the Siccus-type, 10–18 × 6.0–9.0 µm, clavate, pyriform, subcylindrical, subfusoid, thin-walled; projections up to 25, digitate, nodulose, obtuse to subacute, thin- to distinctly thick-walled, up to 8.0 × 1.0 µm, hyaline. PILEOCYSTIDIA absent. STIPITPELLIS a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0(–6.0) µm wide hyphae. CAULOCYSTIDIA single or in groups, 25–55 × 5.0–8.0 µm, erect, suberect or appressed, cylindrical to subfusoid, slightly irregular, slightly

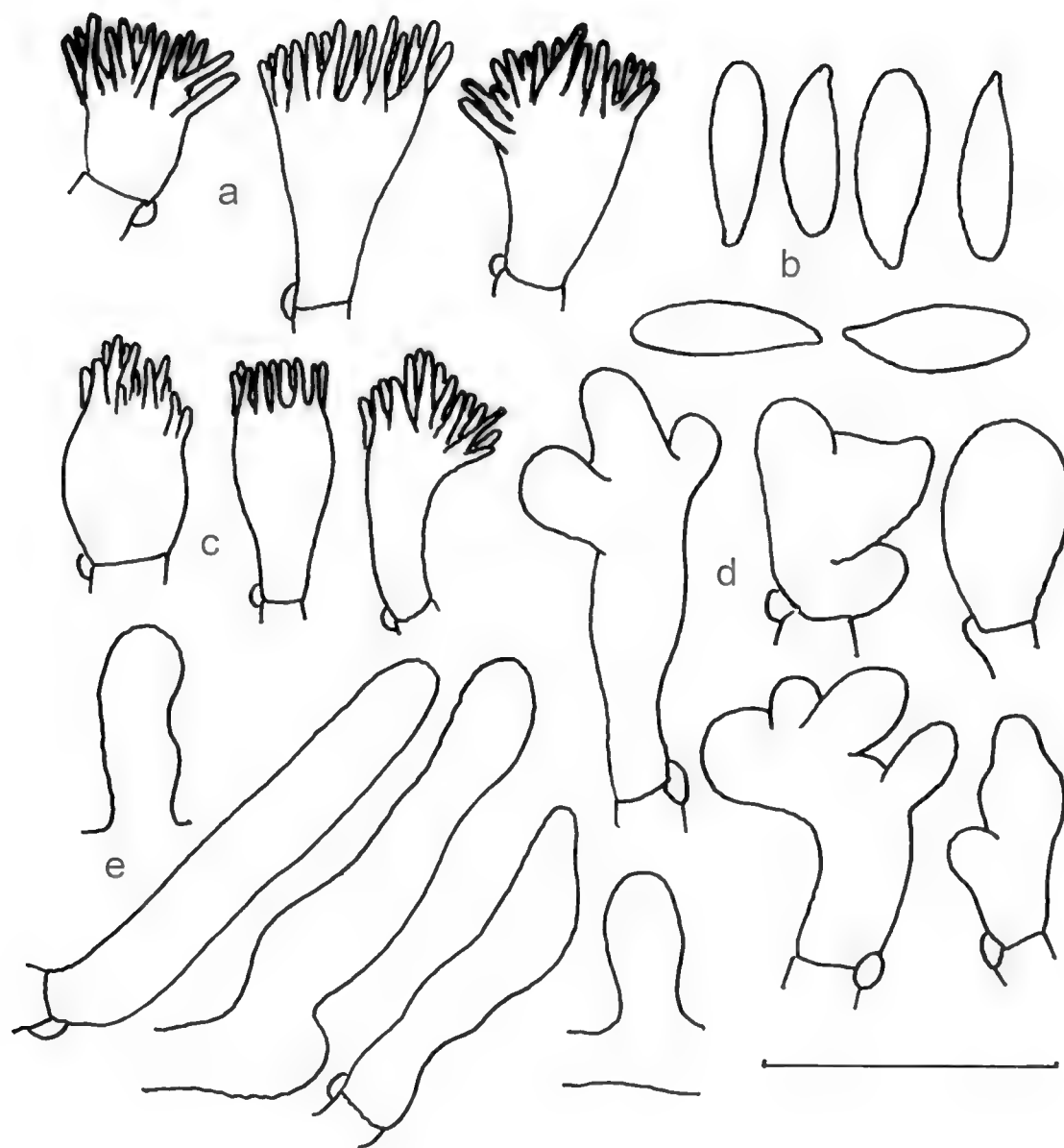


FIG. 2. *Marasmius strobiluriformis*.
a) pileipellis cells, b) basidiospores, c) cheilocystidia of the type 1,
d) cheilocystidia of the type 2, e) caulocystidia.
Scale bar = 20 μ m.

thick-walled, dextrinoid, with hyaline to pale yellowish walls in KOH. CLAMP CONNECTIONS present in all tissues.

HABITAT — On detritus under *Pinus* and *Quercus* sp.

ADDITIONAL COLLECTION — Republic of Korea, Chuncheon, Dongsan-myeon, Bongmyeong-ri, 20 Aug. 2008 leg. R. Ryoo KG 250 (BRNM 714915).

REMARKS — *Marasmius strobiluriformis* is characterized by having a small, convex-hemispherical, then plano-convex, white pilei, rather small basidiospores, dimorphic cheilocystidia (broom cells and rostrate or (often) at apex branched ones), and cylindrical to subfusoid caulocystidia. Due to

the presence of caulocystidia, it belongs to ser. *Atrorubentes* Desjardin & E. Horak.

Among similar species, *Marasmius pseudoniveus* Singer has a larger, 20–40 mm broad, sulcate pilei and smaller (7.5–9 × 3–4 µm) basidiospores (Pegler 1997), *M. halimunensis* Desjardin et al. has a similarly coloured but striate pileus, smaller basidiospores (11–12 × 4 µm), more variable cheilocystidia in shape, and projections and pileipellis consisting of smooth and broom cells (Desjardin et al. 2000), and *M. subarborescens* Singer has a larger, 8–35 mm broad pileus, very close, narrow lamellae, ochraceous-brown stipe at base, smaller basidiospores (6.0–8.0(–9.0) × 2.7–3.2 µm) and dimorphic cheilocystidia in the form of smooth and broom cells (Antonín 2007).

Phylogenetic analysis

Based on ITS and LSU rDNA sequences obtained in this study and from GenBank, the phylogenetic relationships of *Marasmius orientalis* and *M. strobiluriformis* were inferred from Bayesian (MCMC) analyses. ITS and LSU sequences were aligned and the ends trimmed to create a dataset of 656 and 981 base pairs, respectively.

The resulting phylogenetic trees of ITS and LSU rDNA data are shown in Figs. 3 and 4. The independent taxonomic status of two new species was

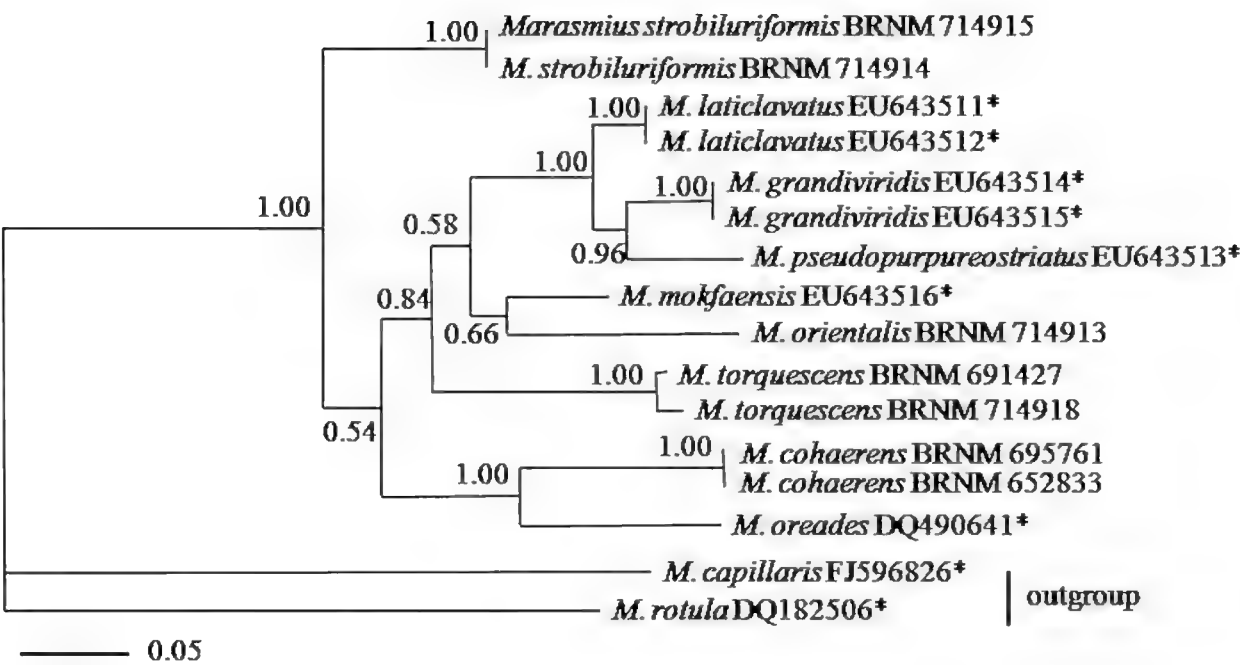


FIG. 3. Phylogenetic tree for *Marasmius orientalis* and *M. strobiluriformis* on the ITS (ITS1, 5.8S rDNA, and ITS2) rDNA region, showing mean branch lengths of a 50 % majority rule consensus tree, obtained from an MCMC analysis of two million generations. An asterisk (*) denotes a sequence from GenBank. Bar = 0.05

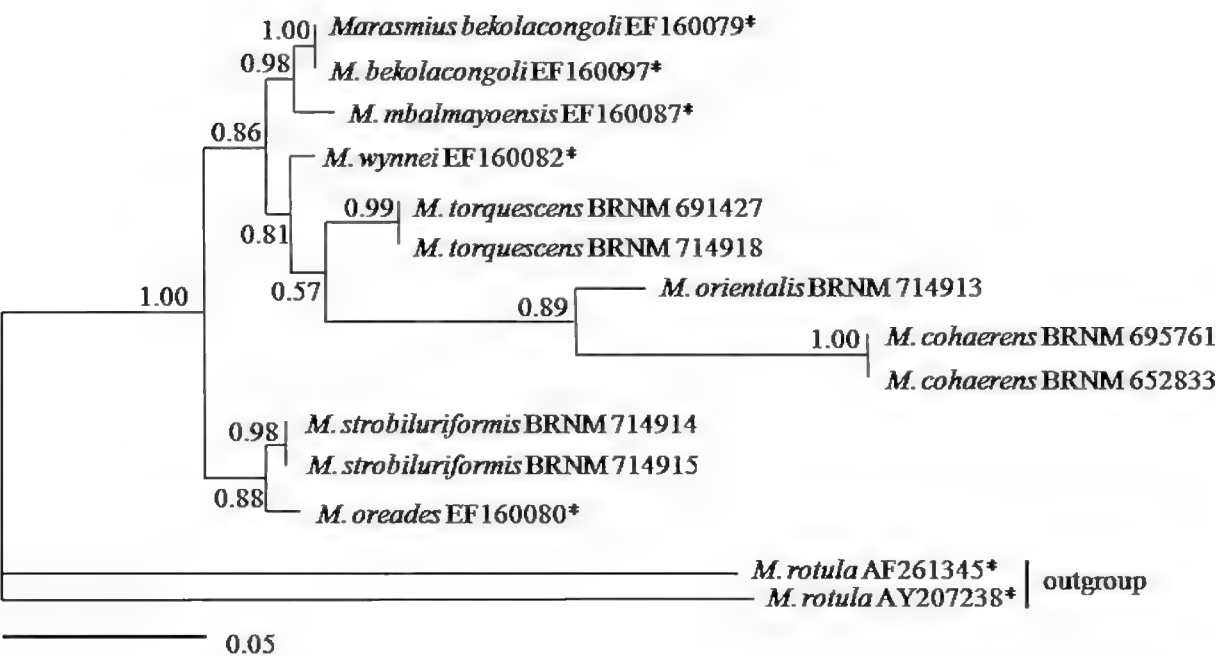


FIG. 4. Phylogenetic tree for *Marasmius orientalis* and *M. strobiluriformis* on the nLSU rDNA (nuclear large subunit ribosomal DNA) sequences, showing mean branch lengths of a 50 % majority rule consensus tree, obtained from an MCMC analysis of two million generations. An asterisk (*) denotes a sequence from GenBank. Bar = 0.05

supported by high posterior probability values. In this study, not only each new species but also *Marasmius torquescens* BRNM 691427 [GU266258 (ITS), GU266265 (LSU)], BRNM 714918 [GU266259 (ITS), GU266266 (LSU)] and *M. cohaerens* BRNM 695761 [GU266260 (ITS), GU266267 (LSU)], BRNM 652833 [GU266261 (ITS), GU266268 (LSU)] were sequenced for the first time. The newly obtained sequences will be analyzed in further study.

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Literature cited

Antonín V. 2007. Monograph of *Marasmius*, *Gloiocephala*, *Palaeocephala* and *Setulipes* in Tropical Africa. Fungus Flora of Tropical Africa 1: 1–164.
Antonín V, Noordeloos ME. 2010. A monograph of marasmioid and collybioid fungi in Europe. IHW Verlag: Eching, Germany. 480 pp.

- Antonín V, Ryoo R, Shin HD. 2009. Marasmiod and gymnopoid fungi of the Republic of Korea. 1. Three interesting species of *Crinipellis* (Basidiomycota, Marasmiaceae). Mycotaxon 108: 429–440.
- Antonín V, Ryoo R, Shin HD. 2010. Marasmiod and gymnopoid fungi of the Republic of Korea. 2. *Marasmius* sect. *Globulares*. Persoonia 24 (DOI: 10.3767/003158510X496107).
- Desjardin DE, Retnowati A, Horak E. 2000. Agaricales of Indonesia. 2. A preliminary monograph of *Marasmius* from Java and Bali. Sydowia 52(2): 92–194.
- Douanla-Meli C, Langer E. 2008. Phylogenetic relationship of *Marasmius mbalmayoensis* sp. nov. to the tropical African *Marasmius bekolacongoli* complex based on nuc-LSU rDNA sequence. Mycologia 100(3): 445–454.
- Geyer CJ. 1991. Markov Chain Monte Carlo maximum likelihood. 156–163, in EM. Keramidas, ed., Computing Science and Statistics. Proceedings of the 23rd Symposium on the Interface. Interface Foundation. Virginia.
- Gilliam MS. 1976. The genus *Marasmius* in the Northeastern United States and adjacent Canada. Mycotaxon 4: 1–144.
- Lee SB, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single spores. 282–287, in: MA. Innis et al., eds., PCR Protocols: a guide to methods and applications. Academic Press San Diego, USA.
- Moncalvo J-M, Vilgalys R, Redhead SA, Jonhnson JE, James TY, Aime C, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller OK Jr. 2002. One hundred and seventeen clades of euagarics. Molecular Phylogenetics Evol. 23: 357–400.
- Pegler DN. 1997. The agarics of São Paulo. An account of the agaricoid fungi (*Holobasidiomycetes*) of São Paulo State, Brazil. Royal Botanic Gardens: Kew (England), 68 pp.
- Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed molds. Bioinformatics 19: 1572–1574.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The CLUSTAL_X Windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Research 25(24): 4876–4882.
- Wannathes N, Desjardin DE, Lumyong S. 2009. Four new species of *Marasmius* section *Globulares* from Northern Thailand. Fungal Diversity 36: 155–163.

New lichen records from Turkey

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Abstract — Four species of lichen forming fungi — *Lecanora praesistens*, *Staurothele levinae*, *Tephromela cypria*, and *Xanthoparmelia ryssolea* — are reported as new to the lichen biota of Turkey. For each a short description is presented.

Key words — Adıyaman, Afyon, *Ascomycetes*, Erzurum, Konya

Introduction

Interest in the lichen biota of Turkey has greatly increased in recent years, while 78 and 73 new lichen-forming and lichenicolous fungi taxa were recorded as new to Turkish lichen biota alone in 2007 and 2008, respectively, whereas 18 of them are newly described species (Candan & Halıcı 2008, Candan & Özdemir-Türk 2008, Çobanoğlu 2007, Halıcı 2008a,b,c,d, Halıcı & Candan 2007, Halıcı & Cansaran-Duman 2007, Halıcı & Güvenç 2008, Halıcı & Hawksworth 2007, 2008; Halıcı et al. 2007a,b,c,d,e,f,g, 2008; Hawksworth & Halıcı 2007, Hertel & Leuckert 2008, Kınalıoğlu 2007a,b, Oran & Öztürk 2007, Özdemir-Türk et al. 2007, Pišút & Guttová 2008, Printzen 2007, Vondrák & Kocourková 2008, Vondrák et al. 2008a,b, Yazıcı & Aptroot 2008, Yazıcı & Aslan 2007, Yazıcı et al. 2007, 2008).

In this present study, some historical collections collected in the last century, which are deposited in herbaria of Natural History Museum Vienna (W) and University of Vienna Herbarium (WU), are re-examined and of these, *Lecanora praesistens* and *Staurothele levinae* are reported as new to Turkish lichen biota, whereas other new records are *Tephromela cypria* and *Xanthoparmelia ryssolea*, which were collected recently from Afyon province by the author, are deposited at the Aegean University Botanical Garden & Herbarium Research and Application Centre (EGE).

Materials and methods

Two of the materials, deposited in W and WU, were studied in Vienna, while the other two were collected from Afyon province in May 2008. For this study, a stereo microscope, a compound microscope and the standard spot tests were used in the identification of the samples, together with the following references: Clauzade & Roux (1985), Guderley & Lumbsch (1999), Esslinger (1977), Kopaczewska et al. (1971), Oxner (1939), Poelt & Vězda (1981), Purvis et al. (1992) and Wirth (1995). Descriptions of the species based both on these literatures and on own observations.

High performance thin-layer chromatography (HPTLC) follows the methods of Arup et al. (1993), however *Buellia subdisciformis* (Leight.) Vain. was used as reference for atranorin and norstictic acid; specimens of *Tephromela atra* (Huds.) Hafellner and *Xanthoparmelia pokornyi* (Körb.) O. Blanco et al. in the private herbarium of the present author were used for comparing the HPTLC results with other lichen substances such α -collatolic, gyrophoric and stenoporic acids.

Results and discussion

Lecanora praesistens Nyl.

Thallus corticolous, crustose, uniform, adnate, dispersed verrucose to verruculose or continuous, yellowish white to cream coloured or greenish grey, epruinose; soredia, isidia and pseudocyphellae absent; photobiont *Trebouxia*; prothallus not visible. Ascomata apothecia, sessile to subimmersed, 0.5–1.6 mm in diam., disc red-brown to blackish brown, intensely dark brown when wet, sometimes reddish orange, epruinose to slightly greyish pruinose; apothecial margins concolorous with thallus, sometimes slightly darker, thin, smooth, entire, verrucose to slightly crenulated; cortex indistinct, hyaline to yellowish, interspersed with small crystals, 20–40 μm laterally, 30–60 μm basally; epihymenium reddish brown to yellowish brown, with crystals, pigmentation and crystals dissolving in KOH, ca 10–15 μm high; hymenium 75 μm tall; amphithecium containing large crystals, not altered by KOH; parathecium hyaline, with small crystals, 10–15 μm thick; hamathecium of paraphyses, about 2 μm thick, simple, sparsely branched, septate, apices slightly capitate. Asci clavate, *Lecanora*-type, (8–)12–16-spored. Ascospores ellipsoid to broadly ellipsoid, rounded at the apices, colourless, simple and smooth-walled, 10–15 \times 5–9 μm . Thallus Pd–, K+ yellow, KC–, C– (HPTLC: Atranorin and chloroatranorin).

DISTRIBUTION—This species is known from different parts of the Alps and the Ukraine (Guderley & Lumbsch 1999).

SPECIMEN EXAMINED—[ADIYAMAN:] Kurdistania occidentalis: Taurus Cataonicus. Inter urbem Malatja et vicum Kjachta, ad truncos vivos *Quercus libani* inter Sindschi et Karatschor, ca 1550 m., 15.7.1910, Heinr. Frh. von Handel-Mazzetti, No 2207, Tageb.-No 462 (W1929–15218 and WU040987).

REMARKS — (1) *Lecanora praesistens* was reported in Steiner (1921) from the locality “Lebende Quercus Libani-Stämme zw. Sindschi u. Karatschor bei Kjachta im kataonischen Taurus, 1550 m” as “*Lecanora subfusca* (L.) Nyl.” This locality correlates to a position between Incile (Sindschi) and Karadut (Karatschor) villages, about 38°02’ N, 38°37’ E.

(2) In this study, these specimens were revised to *L. praesistens*, which differs from *L. allophana* (Ach.) Ach. by its multispored asci. The difference from other multispored corticolous *Lecanora* species are their amphithecium with large crystals, epihymenium with pigmentations and crystals dissolving in KOH, and red-brown to blackish brown apothecial disc (Guderley & Lumbsch 1999).

Staurothele levinae Oxner

Thallus crustose, superficial, orbicular, 1 cm in diam., indistinctly brown or black-brown, moderately thick, in central parts areolate, and narrowly lobate at the periphery; soredia, isidia and pseudocyphellae absent; photobiont *Stichococcus*, also present in hymenium as numerous globose-cuboid or cylindrical hymenial cells between the asci. Ascomata perithecia, ca 0.3 mm in diam., immersed, single in subglobose areoles; ostiole minute, amphithecia thick; true exciple colourless to pale brown; hamathecium of periphyses; paraphyses absent. Asci verrucarioid, without a distinct ocular chamber, 85–95 × 28–31 µm, 2-spored. Ascospores muriform, ± ellipsoid and rounded at apices, 28–52 × 15–26 µm, colourless to dark brown. Hymenial algal cells numerous, simple, pale yellow-green, cylindrical, 6–10 × 3–4 µm. Thallus Pd–, K–, KC–, C– (HPTLC: No lichen products).

DISTRIBUTION—This species is known from Afghanistan, Kazakhstan, Mongolia and Tajikistan (Biazrov et al. 1983, Kopaczewska et al. 1971, Kudratov & Mayrhofer 2002, Steiner & Poelt 1987).

SPECIMENS EXAMINED— [ERZURUM:] Türkei: Ak Dagħ inter oppidum Erzerum et Trapezunt, 25.9.1914, V. Pietschmann (W1959–06485). [KONYA:] Sarai dagħ bei Konia, 1200 m, 1902, E. Zederbauer (W1905–01999).

REMARKS — (1) This species differs from the other *Staurothele* species by its orbicular thallus shape, lobate thallus margin, and dark thallus colour (Oxner 1939).

(2) Both specimens are deposited in W. The specimen from Erzurum was reported in Szatala (1960) as “*S. clopima* (Wahlenb.) Th. Fr.”, and the specimen from Konya in Steiner (1905) as “*S. clopima* var. *protuberans* (Schaer.) J. Steiner”. The recent locality in Erzurum corresponds to Ak Dağ at the approximate coordinates of 40°15’ N, 40°57’ E, and those of Konya to Saray Dağ (= Loras Dağı) at approximately 37°46’ N, 32°21’ E.

(3) These specimens were revised by Maximilian Steiner. Although *S. levinae* is not included in any identification keys, Steiner was familiar with it and distributed it in *Lichenotheca Afghanistanica* as No 7 (Steiner & Poelt, 1987).

Tephromela cypria (Körb.) Hafellner

Thallus crustose, rather thick, wartlike areolate, chalky white to ochre, wide spreading to several cm in diam.; areoles to 2 mm in diam., mostly \pm contiguous and fused, irregular, often wartlike wrinkled; medulla I–; soredia, isidia and pseudocyphellae absent; photobiont chlorococcoid. Ascomata apothecia, up to 3.5 mm in diam., round or irregular, sessile, black; disc flat or concave; thalline exciple conspicuous, persistent, swollen, \pm entire to flexuous at maturity; true exciple thin, \pm inconspicuous, without crystals, but containing dense algal communities; epithecium or hymenium with purplish or greenish, N+ red pigments, epithecium dark red-brown; hymenium 50–60 μ m tall, dark purplish brown or purple-violet, pale purple-violet in upper part; hypothecium \pm ochre below; hamathecium of paraphyses, branching and anastomosing, each with a gelatinous coat; apices with no or just weakly swollen ends, but often with a pigmented hood, 4–5 μ m thick. Asci clavate, *Bacidia*-type, 8-spored. Ascospores simple, colourless, ellipsoid, without a distinct perispore, \pm thick-walled, 10–15 \times 5–8 μ m. Conidiomata pycnidia, immersed; wall colourless except for green pigmentations around the ostiole; conidiogenous cells in chains, pleurogenous; conidia cylindrical or short threadlike, straight, simple, colourless, 9–24 \times 1–1.5 μ m. Cortex Pd–, K+ yellow, KC+ yellow, C– (HPTLC: Atranorin and α -collatolic acid).

ECOLOGY AND DISTRIBUTION—This calcareous rock species was reported from Cyprus, France, Greece, Italy, Portugal, Slovakia, Spain and Sweden (Ajaj et al. 2007, Clauzade & Roux 1985, Kalb & Hafellner 1992, Nimis 1993, Litterski & Mayrhofer 1998, Poelt 1974, Sipman & Raus 1999).

SPECIMEN EXAMINED—AFYON: Emir Mountains, between the villages Çukurcak and Karapınar, 6th km, N 38°45.07', E 31°24.08', alt. 1310 m a.s.l., 13.10.2008, Ayhan Şenkardeşler (EGE 40724).

REMARKS — This species is similar to *Tephromela atra* but differs by its calcicolous habitat, zonate thallus margin, and exciple without crystals but with dense algal communities (Oxner 1939, Kopaczewska et al. 1971). The calcicolous records of *T. atra* from SW Asia need revision, since some specimens belonging to *T. cypria* may have been placed here.

Xanthoparmelia ryssolea (Ach.) O. Blanco et al.

Thallus foliose to subfruticose (indistinctly or not dorsiventral) appressed to subpulvinate, loosely or not at all adnate, 1.5–4.5 cm in diam; lobes 1–3 mm broad, 160–600 μ m thick, convex to irregularly subterete, sometimes folded

or channelled in places, elongate to linear-elongate, rounded or often once or more furcate at the tip, discrete to loosely imbricate or entangled; upper surface yellowish brown to reddish brown, smooth to somewhat pitted or wrinkled at the periphery, inward more or less smooth to grossly rugose, occasionally developing small lobules, dull throughout to somewhat shiny, rarely lightly pruinose; lower surface more or less concolorous with the upper surface or occasionally paler in places, smooth to rugose, occasionally somewhat channelled, dull to shiny, sparsely rhizinate, the rhizines usually only in a few scattered patches which may be present on the upper surface as well, pale or darkening, to 0.6 mm long; soredia, isidia and pseudocyphellae absent; photobiont trebouxoid. Apothecia and pycnidia not seen. Cortex K–, N+ dark blue-green (usually on both sides); medulla PD–, K–, C– or C+ rose-red, CK–, KC+ red (HPTLC: Gyrophoric and stenosporic acids).

ECOLOGY AND DISTRIBUTION—A vagrant species on soil known from Bulgaria, Hungary, Kazakhstan, Mongolia, Rumania, Russia, Spain, and Ukraine (Biazrov 2007, Esslinger 1977, Hawksworth et al. 2008).

SPECIMEN EXAMINED—AFYON: Emir Mountains, between the villages Karapınar and Leylekli, 3rd km, N 38°49.75', E 31°25.60', alt. 1290 m a.s.l., 13.10.2008, Ayhan Şenkardeşler (EGE 40725).

REMARKS — (1) *Xanthoparmelia rysssolea* differs from most other *Xanthoparmelia* species in its vaganoid growth form. Of the vaganoid growth forms, *X. rysssolea* is most likely to be confused with *X. vagans* (Nyl.) Hale and with extreme forms of *X. pokornyi*. The latter two species, however, are distinctly dorsiventral with a moderately rhizinate lower surface that usually darkens centrally. In *X. rysssolea* both cortices give a N+ spot test, while the lower surface of *X. pokornyi* is largely or wholly N–. In addition, *X. rysssolea* characteristically lacks dorsiventrality (often to an extreme extent) and exhibits a very similar pigment production on both sides of the thallus. The few rhizines are usually found on both surfaces and on some large thalli they alternate between the two surfaces (Esslinger 1977).

(2) This species appears together with *Aspicilia desertorum* (Kremp.) Mereschk. var. *desertorum* and var. *semivagans* Mereschk. in this high plateau. Since all three taxa were collected in heaps, they will be distributed later to several institutions as an exsiccate.

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Literature cited

- Ajaj A, El-Assfour A, Ouazzani Touhami A, Benkirane R, Fennane M, Douira A. 2007. Inventaire de la collection des lichens et champignons lichénicoles de l'Herbier national "RAB" de l'Institut Scientifique (Rabat, Maroc). Documents de l'Institut Scientifique n°21: Rabat (Morocco). 70 pp.
- Arup U, Ekman S, Lindblom L, Mattsson J-E. 1993. High performance thin layer chromatography (HPTLC), an improved technique for screening lichen substances. *Lichenologist* 25(1): 61–71.
- Biazrov LG, Gubanov IA, Ganbold E, Dul'gerov AN, Cegmed C. 1983. Flora Vostochnogo Khangaya (MNR). Moskva, Nauka.
- Biazrov LG. 2007. Checklist of the Mongolian Lichens, Version 5. [http://www.sevin.ru/laboratories_eng/biazrov_mong.html (viewed online on 30th March 2009)].
- Candan M, Halıcı MG. 2008. Seven new records of lichenicolous fungi from Turkey. *Mycotaxon* 104: 241–246.
- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ, Adıyaman Provinces of Turkey. *Mycotaxon* 105: 19–22.
- Clauzade G, Roux C. 1985. Likenoj de Okcidenta Europo. Ilustrita Determinlibro. Royan (France), Bulletin de la Societe Botanique du Centre-Ouest, Nouvelle Serie, Numero Special 7.
- Çobanoğlu G. 2007. Lichens from Maslak Campus of Istanbul Technical University. *Turkish J. Bot.* 31: 71–74.
- Esslinger TL. 1977. A chemosystematic revision of the brown *Parmeliae*. *Jour. Hattori Bot. Lab.* 42: 1–211.
- Guderley R, Lumbsch HT. 1999. Notes on multispored species of *Lecanora* sensu stricto. *Lichenologist* 31: 197–210.
- Halıcı MG. 2008a. Some lichen records from Çat forest (Gemerek, Sivas). *Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi* 24: 112–119.
- Halıcı MG. 2008b. A key to the lichenicolous *Ascomycota* (including mitosporic fungi) of Turkey. *Mycotaxon* 104: 253–286.
- Halıcı MG. 2008c. *Arthonia hawksworthii* sp. nov. (*Ascomycota*, *Arthoniaceae*) on *Dimelaena oreina* from Turkey. *Mycotaxon* 105: 89–93.
- Halıcı MG. 2008d. *Llimoniella muralicola* sp. nov. (*Ascomycota*, *Helotiaceae*) on *Protoparmeliopsis muralis* from western Turkey. *Mycotaxon* 105: 203–206.
- Halıcı MG, Candan M. 2007. Notes some lichenicolous fungi species from Turkey. *Turkish J. Bot.* 31: 353–356.
- Halıcı MG, Cansaran-Duman D. 2007. Lichenized and lichenicolous fungi of Yaylacık (Bolu) and Yenice (Karabük) Research Forests in Turkey. *Mycologia Balcanica* 4: 97–103.
- Halıcı MG, Güvenç Ş. 2008. Lichens from the Mediterranean phytogeographical region of Turkey. *Cryptog. Mycol.* 29: 95–106.
- Halıcı MG, Hawksworth DL. 2007. Two new species of lichenicolous fungi from Turkey. *Lichenologist* 39: 439–443.
- Halıcı MG, Hawksworth DL. 2008. Two new species of *Dacampia* (*Ascomycota*, *Dacampiaceae*), with a key to and synopsis of the known species of the genus. *Fung. Diversity* 28: 49–54.
- Halıcı MG, Aksoy A, Kocakaya M. 2007a. Some lichens from Gaziantep, Kahramanmaraş, Kırşehir and Yozgat provinces (Turkey). *Turkish J. Bot.* 31: 161–170.
- Halıcı MG, Atienza V, Hawksworth DL. 2007b. Two new *Polycoccum* (*Dothideales*, *Dacampiaceae*) species on lichens from Turkey. *Mycotaxon* 101: 157–163.
- Halıcı MG, Candan M, Özdemir-Türk A. 2007c. New records of lichenicolous and lichenized fungi from Turkey. *Mycotaxon* 100: 255–260.

- Halıcı MG, Hawksworth DL, Aksoy A. 2007d. Contributions to the lichenized and lichenicolous fungal biota of Turkey. *Mycotaxon* 102: 403–414.
- Halıcı MG, Hawksworth DL, Aksoy A. 2007e. New or interesting lichenicolous fungi records from Turkey. *Nova Hedwigia* 85: 393–401.
- Halıcı MG, Kocourková J, Diederich P, Aksoy A. 2007f. *Endococcus variabilis*, a new species on *Staurothele areolata*. *Mycotaxon* 100: 337–342.
- Halıcı MG, Özdemir-Türk A, Candan M. 2007g. New records of pyrenocarpous lichenicolous fungi from Turkey. *Mycotaxon* 99: 201–206.
- Halıcı MG, Özdemir-Türk A, Candan M. 2008. *Dacampia cladoniicola* sp. nov. (Ascomycota, Dacampiaceae) on *Cladonia* sp. from Turkey. *Mycotaxon* 103: 53–57.
- Hawksworth DL, Blanco O, Divakar PK, Ahti T, Crespo A. 2008. A first checklist of parmelioid and similar lichens in Europe and some adjacent territories, adopting revised generic circumscriptions and with indications of species distributions. *Lichenologist* 40: 1–21.
- Hawksworth DL, Halıcı MG. 2007. *Gemmaspora*, a new verrucarialean genus with remarkable ascospores for *Adelococcus lecanorae* growing on *Aspicilia* species in Syria and Turkey. *Lichenologist* 39: 121–128.
- Hertel H, Leuckert C. 2008. *Lecidea atrobrunnea* in Europe and adjacent parts of Asia and Africa. *Sauteria* 15: 215–238.
- Kalb K, Hafellner J. 1992. Bemerkenswerte Flechten und lichenicole Pilze von der Insel Madeira. *Herzogia* 9: 45–102.
- Kınalıoğlu K. 2007a. The lichen flora of Kocadağ Mountains and its environs (Samsun, Turkey). *Acta Bot. Hung.* 46: 95–104.
- Kınalıoğlu K. 2007b. Lichens of the alpine region in Araklı-Sürmene district, Trabzon province (Turkey). *Cryptog. Mycol.* 28: 159–168.
- Kopaczewskaja EG, Makarevich ME, Oxner AN, Rassadina KA. 1971. Handbook of the Lichens of the USSR. 1. Pertusariaceae, Lecanoraceae, and Parmeliaceae. Leningrad, The Academy Science of U.S.S.R.
- Kudratov I, Mayrhofer H. 2002. Catalogue of the lichenized and lichenicolous fungi of Tajikistan. *Herzogia* 15: 91–128.
- Litterski B, Mayrhofer H. 1998. Catalogue of lichenized and lichenicolous fungi of Cyprus. *Studia Geobot.* 16: 57–70.
- Nimis PL. 1993. The Lichens of Italy. Torino, Museo Regionale di Scienze Naturali.
- Oran S, Öztürk Ş. 2007. Lichen records from Southeast and East Anatolian Region (Turkey). *Journal of Biological and Environmental Sciences* 1: 15–22.
- Oxner AN. 1939. Contribution to the lichen flora of Middle Asia. *Bot. Zhur. (Kiev)* 20: 111–136.
- Özdemir-Türk A, Candan M, Elix JA. 2007. *Xanthoparmelia isidiovagans* (Parmeliaceae), a new lichen record for Turkey. *Turkish J. Bot.* 31: 159–160.
- Pišút I, Guttová A. 2008. Contribution to the lichen flora of Anatolia, Turkey. *Sauteria* 15: 403–415.
- Poelt J. 1974. Bestimmungsschlüssel europäischer Flechten. Vaduz, J. Cramer Verlag.
- Poelt J, Vězda A. 1981. Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft 2. Bibliotheca Lichenologica 16. Vaduz, J. Cramer Verlag.
- Printzen C. 2007. New records of *Cheiromycina* species, a genus of lichenized hyphomycetes, with *C. reimeri* sp. nov. and a revised key to the species. *Nova Hedwigia* 84: 261–267.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM (eds). 1992. The Lichen Flora of Great Britain and Ireland. London, Natural History Museum Publications & British Lichen Society.

- Sipman H, Raus T. 1999. A lichenological comparison of the Paros and Santorini island groups (Aegean, Greece), with annotated checklist. *Willdenowia* 29: 239–297.
- Steiner J. 1905. Lichenes. In Penther A., Zederbauer E. (eds.). *Ergebnisse einer naturwissenschaftlichen Reise zum Erdschias-Dagh (Kleinasien)*. Ann. K.K. Naturhist. Hofmus. 20: 369–384.
- Steiner J. 1921. Lichenes aus Mesopotamien und Kurdistan sowie Syrien und Prinkipo. Ann. Naturhist. Hofmus. 34: 1–68.
- Steiner M, Poelt J. 1987. *Lichenotheca Afganica* No 7. Institute für Botanik, Graz.
- Szatala Ö. 1960. Lichenes Turciae asiaticae ab Victor Pietschmann collecti. *Sydowia* 14: 312–325.
- Vondrák J, Kocourková J. 2008. New lichenicolous *Opegrapha* species on *Caloplaca* from Europe. *Lichenologist* 40: 171–184.
- Vondrák J, Říha P, Arup U, Söchting U. 2008a. The taxonomy of the *Caloplaca citrina* group (*Teloschistaceae*) in the Black Sea Region; with contributions to the cryptic species. 8–37, in J Vondrák, The lichen genus *Caloplaca* (*Teloschistaceae*) and its lichenicolous fungi: contributions to their taxonomy, nomenclature and biodiversity. PhD Thesis, University of South Bohemia, Faculty of Science.
- Vondrák J, Šoun J, Hrouzek P, Říha P, Kubásek J, Palice Z, Söchting U. 2008b. *Caloplaca subalpina* and *C. thracopontica*, two new saxicolous species from the *Caloplaca cerina* group (*Teloschistales*). *Lichenologist* 40: 375–386.
- Wirth V. 1995. Flechtenflora. Bestimmung und ökologische Kennzeichnung der Flechten Südwestdeutschlands und angrenzender Gebiete. Stuttgart, Verlag Eugen Ulmer.
- Yazıcı K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. *Mycotaxon* 105: 95–104.
- Yazıcı K, Aptroot A, Aslan A. 2007. Lichen biota of Zonguldak, Turkey. *Mycotaxon* 102: 257–260.
- Yazıcı K, Aptroot A, Etayo J, Aslan A, Guttová A. 2008. Lichens from the Batman, Mardin, Osmaniye, and Sivas regions of Turkey. *Mycotaxon* 103: 141–144.
- Yazıcı K, Aslan A. 2007. Lichens and lichenicolous fungi from Bayburt Province (Turkey). *Acta Bot. Hung.* 49: 199–213.

Four *Parmeliaceae* species excluded from *Bulbothrix*

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Abstract — Four species previously included in the genus *Bulbothrix* are shown not to form bulbate cilia and are combined into alternative genera as *Hypotrachyna tuskiformis*, *Parmelinopsis pinguiacida*, *P. subinflata*, and *Parmotrema yunnanum*. All species are described in detail and a lectotype is selected for *Bulbothrix tuskiformis*.

Key words — *Bulbothrix pinguiacida*, *Bulbothrix subinflata*, *Bulbothrix yunnana*

Introduction

The genus *Bulbothrix* Hale was proposed for a group of species previously included in *Parmelia* ser. *Bicornutae* (Lynge) Hale & Kurokawa (Hale 1974) characterized by small lacinate, adnate thalli, bulbate marginal cilia, cortical atranorin, simple to branched cilia and rhizines, smooth to coronate apothecia, unicellular, colorless, ellipsoid to bicornute ascospores $5\text{--}21 \times 4\text{--}12 \mu\text{m}$, and small, bacilliform to bifusiform conidia $5\text{--}10 \mu\text{m}$ long (Hale 1976b, Elix 1993a).

During a taxonomic revision of the genus we found four species previously included in *Bulbothrix* that do not have the typical cilia with hollow basal bulbae that contain differentiated cells and an oily substance (Hale 1975, Feuerer & Marth 1997) should be classified outside this genus.

These four species are distributed in Southeast Asia and Oceania. *Hypotrachyna tuskiformis* is still only known from the type locality in Papua New Guinea (Elix 1997b), *Parmelinopsis pinguiacida* from New Caledonia and Rarotonga (Louwhoff & Elix 2000a, 2000b), *Parmelinopsis subinflata* from the Philippines, Australia, Malaysia, and Papua New Guinea (Hale 1965, 1976b, Sipman 1993, Streimann 1986), and *Parmotrema yunnanum* from southern China (Wang et al. 2000).

Material and methods

The morphological characteristics were examined under a stereomicroscope, with special attention given to the cilia and rhizines. Anatomical sections of the thalli and

apothecia were made by hand, using steel razor blades. The secondary compounds in the medulla are taken from the literature (Hale 1965, Sipman 1993, Louwhoff & Elix 2000a), having been identified by high performance liquid chromatography (HPLC). The species are described following a detailed standardized protocol adopted by the Lichenological Study Group of the Instituto de Botânica in an effort to generate uniform descriptions for all *Parmeliaceae* species.

For the definition of the bulbae of true bulbate cilia we follow the descriptions in Hale (1975) and Feuerer & Marth (1997). They are globular or oval, hollow structures, with an inflated aspect and paraplectenchymatous carbonized walls formed by agglutinated hyphae, which contain oil-forming cells (idioblasts) and a colorless oily substance (yellowish or reddish in older thalli or herbarium specimens). These bulbae usually appear on cilia at the thallus margins, amphithecia, isidia, and sometimes on the upper cortex and the base of rhizines.

According to our interpretation, in *Parmeliaceae*, cilia are basically marginal structures while rhizines grow laminal. Submarginal structures anatomically similar to cilia are interpreted as rhizines if there is a morphological continuity from the border to the center of the thallus that normally presents only a range in size due the structure ageing. A submarginal structure that is evidently longer than the young ones surrounding it or is growing from a nude marginal zone is considered a cilium.

The method used to confirm the anatomical structure of cilia consists of removing a portion of the thalline margin, gently dissecting it [razor blade], and placing it on a glass slide containing a drop of commercial bleach (sodium hypochlorite) solution.

The solution gradually clarifies the sample without damaging the structure of the hyphae, dissolving the dark pigment of the cilia and rhizines and making it easy to visualize the hyphae, and in the case of true basal bulbae, the internal cavity, the idioblasts, and the oily substances present.

Following this procedure, the structures are gently compressed (which can also be done without the C clarification), in order to verify the presence of the idioblasts and oily substances under the optical microscope.

Hypotrachyna tuskiformis* (Elix) Benatti & Marcelli, *comb. nov.

FIG. 1

MYCOBANK MB 515685

= *Bulbothrix tuskiformis* Elix, Mycotaxon 65: 482. 1997.

LECTOTYPE (HERE DESIGNATED)—Papua New Guinea, Southern Highlands, Andawe River, Lama Sawmill logging area, 6 km SE of Ialibu, 6°20'S, 144°01'E, 1840 m, on *Nothofagus* crown in *Nothofagus-Podocarpus* forest, J.A. Elix & H. Streimann 12680A, 11-XII-1982 (CANB!).

THALLUS laciniate, sublinear, becoming pale dusky gray in the herbarium, fragments up to 3.0 cm diam., subcoriaceous, corticolous, upper cortex 7.5–12.5 µm thick, algal layer 15.0–20.0 µm thick, medulla 57.5–80.0 µm thick, lower cortex 7.5–12.5 µm thick. Laciniae dichotomous or trichotomous branched or occasionally irregularly ramified, 0.3–0.8 (–1.2) mm wide, contiguous to weakly imbricate in the center, adnate and adpressed, with flat, truncate apices, the

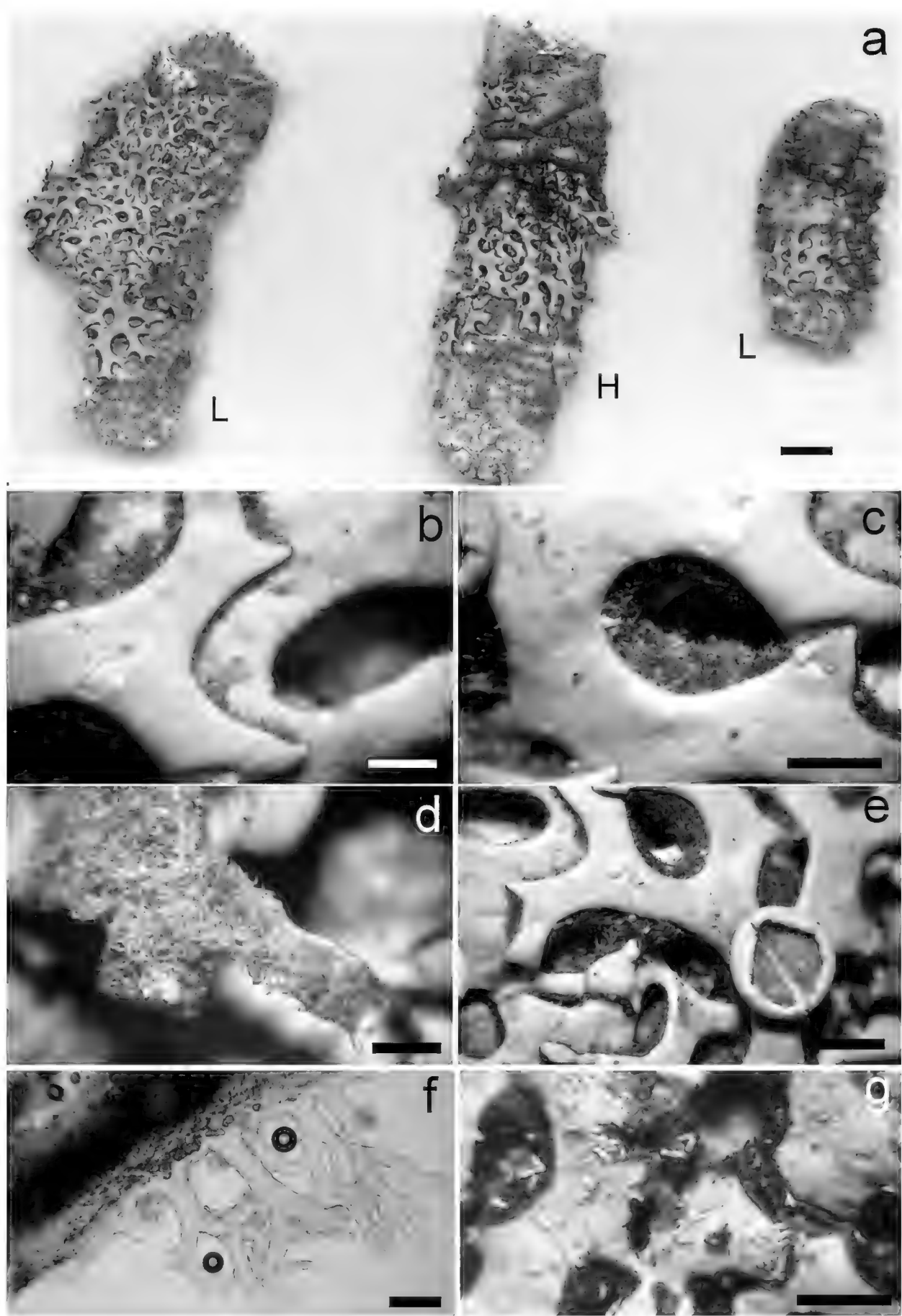


FIGURE 1. Type material of *Hypotrachyna tuskiformis* (CANB).
a - the lectotype (L) with the *Hypotrachyna* specimen in between (H); b–c - detail of cilia;
d - tomentum; e-apothecium; f - rhizines; g - isidia of the inmixed *Hypotrachyna* specimen.
Bars: a = 5mm; b–e and g = 1 mm; f = 0.2 mm

margins flat, smooth, entire, the axils oval or irregularly shaped, upper cortex continuous and smooth with transversal cracks on older parts. MACULAE absent. CILIA absent, however the rhizines often grow close to the edge of the lower marginal zone and project beyond it, eventually turning to the side or upwards. LACINULAE scarce, marginal and adventitious, short, flat, simple, truncate or sometimes acute, underside concolorous with the lower marginal zone, $0.2\text{--}1.0 \times 0.1\text{--}0.2$ mm wide. SOREDIA, PUSTULAE and ISIDIA absent. MEDULLA white. LOWER SURFACE pale brown, shiny, smooth, densely rhizinate. MARGINAL ZONE pale brown, not distinct from the center, shiny, smooth, generally rhizinate to the margin. RHIZINAE pale brown, concolorous with the lower cortex or darker, initially furcate in the marginal zone but becoming densely dichotomous or irregularly branched toward the center, not bulbate at the base and lacking dark swellings, $0.10\text{--}0.40 \times \text{ca. } 0.02$ mm, with abundant tomentose rhizoids projecting to 1 cm beyond the edges, evenly distributed. APOTHECIA subplane to concave, adnate to substipitate, $0.4\text{--}1.2$ mm diam., laminal, margin smooth eventually fissured when old, amphithecium smooth, rugose on the junction with the stipe, not ornamented. Disc pale brown, epruinose, imperforate, epithecium $10.0\text{--}12.5$ μm high, hymenium $62.5\text{--}75.0$ μm high, subhymenium $20.0\text{--}25.0$ μm high. ASCOSPORES reniform to allantoid, $9.0\text{--}12.0 \times 2.0\text{--}4.0$ μm , epispore ca. 0.75 μm thick. PYCNIDIA sparse, laminal, ostiole black. CONIDIA bacilliform to short filiform, $5.0\text{--}7.5$ ($\text{--}9.5$) $\times 0.75$ μm .

SPOT TESTS: cortex K+ yellow, UV–; medulla K+ yellow \rightarrow dark red, C–, KC–, P+ yellow, UV–.

TLC/HPLC: cortical atranorin; medullary salazinic acid and consalazinic acid (Elix 1997b).

DISTRIBUTION—Oceania: Papua New Guinea (Elix 1997b).

COMMENTS—*Hypotrachyna tuskiformis* is characterized by the sublinear dichotomously branched laciniae, a smooth, continuous, emaculate upper cortex, smooth and sinuous, eciliate margins, the absence of vegetative propagules, a pale brown lower cortex covered with dense brown dichotomously branched rhizines, a smooth unornamented apothecial margin, reniform to allantoid ascospores, bacilliform or short filiform conidia, and the presence of cortical atranorin and medullary salazinic acid.

This species is here tentatively placed in *Hypotrachyna* because of the absence of marginal cilia and presence of dense dichotomous rhizines and the aspect of the laciniae.

The holotype consists of three fragments on pieces of bark glued to the voucher. Two fragments (marked as “A” in the sample and “L” in FIG. 1) belong to the same species, and meet most of the features mentioned in the original description (Elix 1997b), except for the absence of marginal cilia. The larger

fragment is fertile, while the other is small, ca. 1 cm wide. These fragments were selected as the lectotype of *H. tuskiformis*.

The fragment in between, ca. 2 cm wide, belongs to another species of *Hypotrachyna* (FIG. 1a, marked H). This species has a black lower cortex and rhizines, is densely maculate and isidiate (FIG. 1g). The black margin is more obvious in this specimen than in the other two fragments, due to the dark lower cortex. Spot tests indicate that this fragment also contains medullary salazinic acid. We have not studied it further as it is unrelated to *Bulbothrix*.

Another characteristic that differs from the original description relates to the ascospores, which were described as being semi-lunate like those of *B. semilunata* (Lynge) Hale (S!) or *B. bicornuta* (Müll. Arg.) Hale (BM! and G!). In fact they are allantoid or reniform.

Bicornute (semi-lunate) ascospores are crescent-shaped with acute apices, while those of *H. tuskiformis* have short, rounded apices, and are narrow bean- or kidney-shaped. In bicornute ascospores the lumen is restricted to the central portion of the spore, while in the allantoid or reniform ascospores, the lumen is uniformly distributed throughout.

According to Elix (1997b), *B. tuskiformis* resembles *B. suffixa* (Stirt.) Hale (BM! holotype, GLAM! isotype), which has laciniae with closer internodes, more sinuous and irregular margins, and bulbate cilia.

***Parmelinopsis pinguiacida* (Louwhoff & Elix) Marcelli & Benatti, comb. nov.**

MYCOBANK MB 515686

FIG. 2 A–D

= *Bulbothrix pinguiacida* Louwhoff & Elix, Mycotaxon 75: 195. 2000.

HOLOTYPE—New Caledonia, Grande Terre, Ciu Cascades, near Canala, 21°37'S, 165°38'E, 400 m, on exposed rocks, S.H.J.J. Louwhoff & J.M. Porigneaux 754, 29-VI-1999 (PC, isotype in CANB!).

THALLUS sublaciniate, subirregular, pale dusky gray in the herbarium, fragment up to 3.0 cm diam., submembranaceous, saxicolous, upper cortex 10.0–15.0 µm thick, algal layer 15.0–25.0 µm thick, medulla 25.0–37.5 µm thick, lower cortex 12.5–17.5 µm thick. Laciniae irregularly to subdichotomously branched, 0.9–2.6 mm wide, subimbricate, weakly to loosely adnate, with flat, subrotund to truncate apices, the margins slightly undulate, crenate to sinuous, entire to incised, sometimes sublacinulate, with a distinct, thick and massive marginal black line thickening mainly in the axils, the axils oval to irregular, upper surface continuous and smooth, occasionally with a few irregular cracks. **MACULAE** absent. **CILIA** black, simple, with long, rarely furcate, ascending apices, 0.05–1.00 × ca. 0.05 mm, the base frequently enlarged but not bulbate, originating in part from massive, thickened portions (0.05–0.45 mm thick) of the black, marginal line, frequent throughout or mainly restricted to the axils. **LACINULAE** common in the older parts, marginal, adventitious, short, flat,

simple to furcate or irregularly branched, subrotund to truncate, underside concolorous with the lower marginal zone, $0.05\text{--}0.80 \times 0.05\text{--}0.50$ mm. SOREDIA (see comments) and ISIDIA absent. PUSTULOID STRUCTURES appearing from the margins or sometimes on the apices of adventitious lacinulae, rugose and somewhat distorted, hollow in part, the walls occasionally breaking down to form coarse granules, resembling corticate, granular soredia. MEDULLA white. LOWER SURFACE black, shiny, smooth, sometimes slightly veined, sparsely rhizinate. MARGINAL ZONE attenuate, brown, shiny, $0.5\text{--}1.5$ mm wide, smooth to subrugose or veined, usually naked. RHIZINAE black, simple, acute, without bulbate bases or dark swellings, $0.10\text{--}0.70 \times \text{ca. } 0.05$ mm, sparse, sometimes agglutinated. APOTHECIA and PYCNIDIA not seen.

SPOT TESTS: cortex K+ yellow, UV–; medulla K–, C–, KC–, P–, UV–.

TLC/HPLC: cortical atranorin and chloroatranorin; medullary unknown fatty acids and traces of lecanoric acid (possibly a contaminant) (Louwhoff & Elix 2000a).

DISTRIBUTION—Oceania: New Caledonia (Louwhoff & Elix 2000a) and Rarotonga (Louwhoff & Elix 2000b).

COMMENTS—*Parmelinopsis pinguiacida* is characterized by the smooth and continuous, emaculate upper cortex, subirregular laciniae with sinuous, crenate margins, cilia often with enlarged bases, the formation of marginal pustules which form corticate granules, a black lower cortex with black, simple, sparse rhizinae, and by the presence of medullary fatty acids.

The holotype has not yet been located in PC. The isotype in CANB consists of a fragment (half of the original thallus) on a small piece of rock. The material is consistent with the photograph in Louwhoff & Elix (2000a) and the description given by the authors, who correctly reported the base of the cilia as being “enlarged, but not conspicuously bulbate”.

We found no genuine bulbate cilia or rhizines. Although several cilia had a wide base, they are neither globose nor oval, do not have an internal cavity, and contain neither the typical cells (idioblasts) nor the oily substance present in true bulbae as seen in species of *Bulbothrix* or *Relicina* (Hale 1975, 1976b, Feuerer & Marth 1997).

Cilia with broad bases are often observed in *Parmelinopsis*, e.g., in *P. minarum* (Vain.) Elix & Hale and *P. horrescens* (Taylor) Elix & Hale, and less distinctly in *P. damaziana* (Zahlbr.) Elix & Hale, *P. spumosa* (Asahina) Elix & Hale and *P. subinflata* (see ahead). These are not really bulbate but inflated, although not always as distinct as those seen in the type material of *P. pinguiacida* (and of *P. subinflata*, see below).

In the axils of the laciniae and crenae, the thickening of the black marginal line somewhat resembles that seen in the type of *Parmotrema yunnanum*

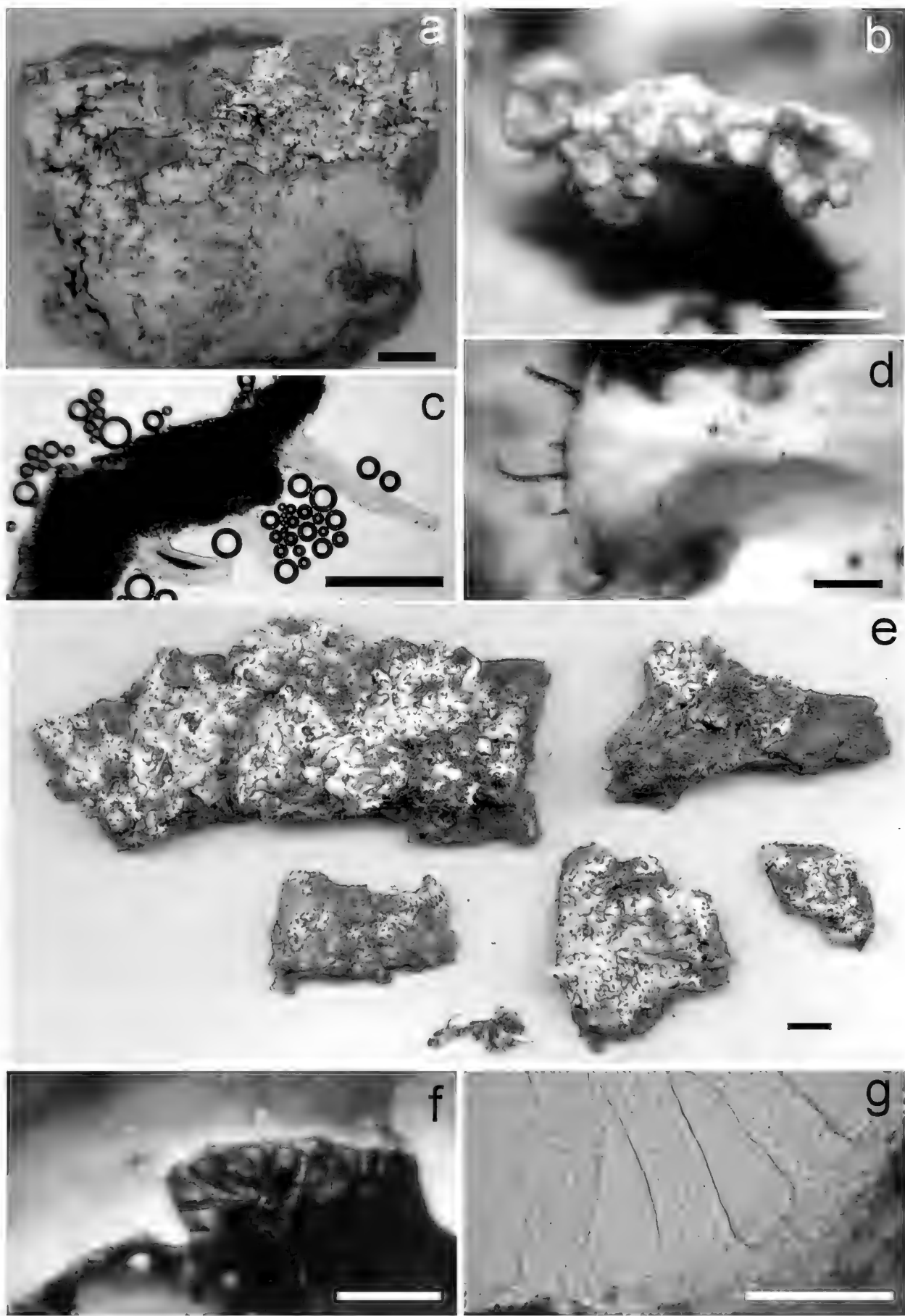


FIGURE 2. a–d - isotype of *Parmelinopsis pinguiacida* (CANB).
a - thallus; b - pustuloid structure; c–d - details of the cilia.
e–g - holotype of *Parmelinopsis subinflata* (US): e - thallus; f–g - details of the cilia.
Bars: a - 5 mm; b–f = 0.5 mm; g = 0.1 mm.

(see below). The thickened margin of both species is not hollow, there are no idioblasts, and no oily substance. There is no evidence that this thickening occurs from an enlarged and very extended bulba, as occurs for example in *B. tabacina* (Mont. & Bosch) Hale or *B. ventricosa* (Hale & Kurok.) Hale, or by somewhat laterally fused bulbae of any kind.

We are unsure about what the authors referred to as the presence of pustules (Louwhoff & Elix 2000a). Pustules are not distinct on the isotype, and we are not sure that the observable deformations of the thallus surface really represent such structures. These “pustuloid” structures are mainly marginal and not fully hollow, forming corticated granular soredia, where the walls disintegrate in part, into coarse granules.

Louwhoff & Elix (2000a) compared *B. pinguicida* to *B. lopezii* Hale, which has apically branched cilia, true basal bulbae containing the characteristic idioblasts and oily substances, and form dense dichotomous laminal lacinulae, but lacks vegetative propagules.

Parmelinopsis spumosa and *P. subfatiscens* (Kurok.) Elix & Hale form laminal pustules, rather than marginal ‘pustuloid structures’, and have different medullary chemistries that react with spot tests (Hale 1976a).

***Parmelinopsis subinflata* (Hale) Benatti & Marcelli, comb. nov.**

FIG. 2 e–g

MYCOBANK MB 515687

= *Parmelia subinflata* Hale, Journal of Japanese Botany 40: 201. 1965.

HOLOTYPE—Philippines, Negros Occidental, near Mt. Mandalagan, ILCO logging area in virgin dipterocarp forest about 50 miles south of Fabrica, alt, 850 m, M. E. Hale & J. Banaag 26641, VII-1964 (US!; isotypes in TNS! and UPS!).

= *Bulbothrix subinflata* (Hale) Hale, Phytologia 28(5): 481. 1974.

= *Parmelinopsis protocetrarica* Elix, Mycotaxon 47: 119. 1993 (CANB!, holotype).

THALLUS sublaciniate, sublinear, pale dusky in the herbarium, fragments up to 4.0 cm wide, submembranaceous, corticolous, upper cortex 12.5–15.0 µm thick, algal layer 12.5–17.5 µm thick, medulla 75.0–90.0 µm thick, lower cortex 10.0–17.5 µm thick. Lobes irregularly to dichotomously branched, 0.3–1.1 (–1.7) mm wide, contiguous or becoming slightly imbricate to the center, adnate and adpressed, with flat to involute, subtruncate to truncate or sometimes acute apices, the margins flat to slightly involute, subcrenate to sinuous or somewhat subirregular, entire to partly incised, frequently sublacinulate, the axils oval, upper surface smooth and continuous, ±subrugose on older parts. **MACULAE** absent. **CILIA** black, with simple, rarely irregularly ramified and commonly descending apices, 0.05–0.25 (–0.50) × ca. 0.05 mm, base occasionally enlarged but not bulbate, frequent along the margin or becoming more abundant in some parts, usually absent or sparse on the apices of the laciniae. **LACINULAE**

common, marginal and adventitious, short, flat, simple to irregularly branched, truncate to acute, underside concolorous with the lower marginal zone, $0.1\text{--}0.6 \times 0.1\text{--}0.2$ mm. SOREDIA and PUSTULAE absent. ISIDIA granular to smooth and short cylindrical or sublageniform, $0.05\text{--}0.35$ (-0.70) $\times 0.05\text{--}0.10$ mm, simple to sparsely branched, erect, straight to curved, usually caducous, concolorous with the cortex, eciliate, appearing in small sparse groups, laminal or occasionally marginal. MEDULLA white. LOWER SURFACE pale brown to ivory white on some erhizinate parts, shiny, smooth, papillate to moderately or densely rhizinate. MARGINAL ZONE indistinct from the center, pale brown to ivory white, shiny, smooth, papillate or rhizinate. RHIZINAE black, initially simple and acute but soon becoming subdichotomous, squarrose or irregularly branched, with occasionally slightly enlarged but non-bulbous bases, $0.10\text{--}0.80 \times \text{ca. } 0.05$ mm, frequent to abundant and causing a somewhat tomentose aspect on some parts, \pm evenly distributed to partially grouped. APOTHECIA subconcave, adnate, $0.3\text{--}0.8$ mm diam., laminal, margins crenate and rugose, amphithecium smooth, occasionally isidiate. Disc pale brown, epruinose, imperforate, epithecium $7.5\text{--}10.0$ μm high, hymenium and subhymenium (poorly developed and hard to distinguish) $37.5\text{--}52.5$ μm high. ASCOSPORES not seen (hymenium without asci). PYCNIDIA sparse, laminal, with black ostioles. CONIDIA bacilliform, $3.0\text{--}6.0 \times 0.75$ μm .

SPOT TESTS: cortex K+ yellow, UV–; medulla K–, C–, KC+ rose, P+ orange, UV–.

TLC/HPLC: cortical atranorin; medullary protocetraric acid (Hale 1965, 1976b).

DISTRIBUTION—Oceania: Papua New Guinea (Streimann 1986). Asia: Philippines (Hale 1965, 1976b), Malaysia (Hale 1965, 1976b, Sipman 1993). Australia (Elix 1993b).

COMMENTS—*Parmelinopsis subinflata* is characterized by the smooth, emaculate upper cortex, narrow sublinear laciniae, subcrenate to sinuous margins, cilia with partially enlarged bases, simple laminal eciliate isidia, pale brown to ivory white lower cortex, simple to irregularly branched black rhizines, and presence of medullary protocetraric acid.

The type material consists of fragments on pieces of bark, some of them with a few immature apothecia and a few pycnidia. Some fragments are more isidiate than others. The comments of Hale (1965, 1976b) give the impression that the cilia are bulbous, but the inflation of the bases is barely perceptible. Even in the photograph showing the cilia in detail (Hale 1965) one cannot see bulbous clearly.

Contrary to what was described by Hale (1965, 1976b), bulbous appeared totally absent from the cilia and the base of rhizines in the type material.

Occasionally, some of the cilia are slightly expanded at the base due to the development of the marginal black line that thickens in some parts. This is somewhat similar but less prominent than that observed in *P. pinguiacida*.

No cilia in the specimens examined had typical *Bulbothrix*-type bulbae, but they were consistent with those commonly found in *Parmelinopsis*. No evidence for the formation of basal bulbae or the presence of the oily substance commonly found in *Bulbothrix* was observed. Further, the margin has a distinct and salient black line, very common in this genus.

The isidia of *P. subinflata* are simple or rarely weakly branched, eciliate and concolorous to the upper cortex. They are very scarce in the type material, forming small scattered groups, but sometimes they also occur on the margins.

The lower cortex is pale brown, becoming ivory white where the papillae and rhizines are absent. The rhizines tend to form entangled clusters, leaving some parts of the lower surface bare. There is a tendency of these clusters to be formed in the more distal portions of laciniae, whereas the ivory white color is usually restricted to the proximal areas.

Hale (1976b) compared *B. subinflata* to *B. pigmentacea* (Hale) Hale, citing only differences in altitude where the species occur in the same locality. *Bulbothrix pigmentacea* (US! holotype) has apically branched, genuine bulbate cilia and rhizines, lacks medullary acids, and has a K– reddish pigment in spots in the medulla, lower cortex, and rhizines.

Bulbothrix chowoensis (Hale) Hale is a further species that contains medullary protocetraric acid (Hale 1976b), but it lacks isidia. Hale commented that *B. chowoensis* “had no strongly bulbate cilia” in his comments on *B. subinflata*, and did not describe the cilia in his description of *B. chowoensis*. However, the type material of *B. chowoensis* (BM! holotype, US! isotype) is a genuine *Bulbothrix* with sparse cilia, similar to those normally found in *Bulbothrix* species containing medullary norstictic acid.

Parmelinopsis jamesii (Hale) Elix & Hale (Hale 1972) is also similar to *P. subinflata* but contains fumarprotocetraric as the principal medullary acid, with protocetraric acid being a minor accessory. *P. jamesii* also differs in having wider laciniae (1.5–3.0 mm) and a black lower cortex (Hale 1972, 1976a). Although the rhizines of *P. jamesii* were described as being simple, they can become sparsely squarrose branched like those in the type of *P. subinflata*.

Parmelinopsis protocetrarica (CANB! holotype) is being placed in the synonymy of *P. subinflata*. Comparison of the type material of both denotes only that the material of *P. protocetrarica* is more isidiate. The descriptions of *P. protocetrarica* (Elix 1993b, Louwhoff & Elix 2002) mention gyrophoric acid as another (minor) medullary substance, the only apparent difference between

the types. We are not sure if the gyrophoric acid is a common or occasional accessory secondary substance present in this species, or whether it may possibly be a contaminant.

Parmotrema yunnanum (Sheng L. Wang, J.B. Chen & Elix) Marcelli & Benatti,

comb. nov.

FIG. 3

MYCOBANK MB 515688

= *Bulbothrix yunnana* Sheng L. Wang, J.B. Chen & Elix. Mycotaxon 76: 293. 2000.

HOLOTYPE—China, Yunnan, Zhongdian County, 3700 m, on bark of *Acer* sp., X.Y. Wang, X. Xiao & J.J. Su 5669, 14-VIII-1981 (HMAS-L!, isotype in CANB!).

THALLUS laciniate, subirregular to sublinear, dusky gray in the herbarium, fragments up to 4.2 cm diam., coriaceous, corticolous, upper cortex 15.0–20.0 µm thick, algal layer 15.0–25.0 µm thick, medulla 42.5–60.0 µm thick, lower cortex 17.5–25.0 µm thick. Lobes irregularly dichotomously to partially anisotomic dichotomously ramified, 0.7–3.2 mm wide, contiguous to slightly imbricate or crowded, adnate and adpressed, with flat to involute, subtruncate to truncate apices, the margins flat, subcrenate to crenate or irregular, entire to slightly incised, moderately sublacinulate at some parts, the axils oval or irregular, upper surface smooth and continuous, occasionally irregularly cracked (sometimes the cracks hidden by lacinules). **MACULAE** punctiform, laminal, distinguishable mainly on young parts and in some areas of the center, sometimes aggregating and forming larger effigurate spots. **CILIA** black, the initially simple and long apices commonly becoming irregularly branched, 0.05–1.35 × 0.03–0.10 mm, base occasionally enlarged but not bulbate, originating from a thick, massive, and irregularly interrupted black marginal line, 0.05–0.55 mm thick, frequent throughout the margin but becoming more prominent in the axils and adjacent areas, absent at the apices of laciniae. **LACINULES** frequent to abundant, mostly laminal, sometimes also marginal (partially adventitious), usually prostrate on the cortex or one over the other, short, flat to slightly circinate, initially simple and oblong or spathuliform becoming furcate or irregular as they develop, truncate, underside brown, black or concolorous with the lower marginal zone, 0.05–0.40 (–1.00) × 0.05–0.20 (–0.60) mm. **SOREDIA**, **PUSTULES** and **ISIDIA** absent. **MEDULLA** white. **LOWER SURFACE** black, shiny, smooth to subrugose, densely rhizinate. **MARGINAL ZONE** indistinct from the center to attenuated, black to brown, shiny, 0.5–1.5 mm wide, smooth, slightly papillate, generally rhizinate to the edges. **RHIZINES** black, even at the marginal zone, initially simple or frequently furcate, irregularly or squarrosely branched, without bulbate bases or dark swellings, 0.10–1.25 × 0.03–0.10 (–0.15) mm, abundant, evenly distributed, commonly agglutinated. **APOTHECIA** concave to plane, substipitate to sessile, 0.5–3.2 mm diam., laminal, margins smooth

to irregular sometimes turning involute and retorted, eciliate, amphithecium smooth becoming rugose, lacking ornamentation. Disc pale brown to brown, epruinose, imperforate, epithecium 7.5–10.0 μm high, hymenium 45.0–50.0 μm high, subhymenium 30.0–35.0 μm high. ASCOSPORES ellipsoid, the apices sometimes slightly acuminate, with a spindle like aspect, 7.5–12.5 \times 4.0–5.0 μm , episore ca. 0.5 μm . PYCNIDIA not seen.

SPOT TESTS: cortex K+ yellow, UV–; medulla K–, C–, KC–, P–, UV–.

TLC/HPLC: cortical atranorin; medullary caperatic acid and traces of unknown fatty acids (Wang et al. 2000). According to a label added to the isotype, Elix restudied the chemistry in 2006 by TLC in solvent C, and found secalononic acids A and C, and an unidentified fatty acid (Rf 17).

DISTRIBUTION—Asia: China (Wang et al. 2000).

COMMENTS—This species is misplaced in *Bulbothrix* and is being very tentatively placed in *Parmotrema* based on the habit of the thallus, and the size and conformation the lobes.

The punctiform and effigurate maculae pattern and the branched and squarrose cilia and rhizines place this species possibly in the group related to *Parmotrema consors* (Nyl.) Krog & Swinscow; taxa in this group have formerly been included in *Canomaculina* [*Rimelia*,] or *Rimeliella*, genera now synonymised with *Parmotrema* (Elix & Hale 1987, Elix 1997a, Blanco et al. 2005).

Parmotrema yunnanum is characterized by subirregular laciniae, a smooth upper cortex, the formation of circinate, eciliate laminal lacinulae, simple to irregularly branched cilia, a thick and massive marginal black line, black lower cortex, simple to irregularly branched or weakly squarrose rhizines, unornamented apothecia, and by the presence of medullary secalononic and fatty acids. The ascospores are small for the genus, usually ellipsoid but sometimes fusiform with a slightly acuminate apex.

The holotype and isotype consist of several fragments in good condition. Although the holotype contains several apothecia, the isotype is sterile. Seen without a stereomicroscope, the thallus appears to have several small procumbent isidia on its surface, due to the circinate aspect of the lacinulae.

Parmotrema yunnanum was described as having “cilia tapered or weakly inflated at the base, \pm apically branched” (Wang et al. 2000), suggesting that this species was not a true *Bulbothrix*, but belongs to some other ciliate *Parmeliaceae* where the cilia have an enlarged base instead of being truly bulbate.

Further, the type material lacks idioblasts and the oily substances present in *Bulbothrix* (Hale 1975, Feuerer & Marth 1997). The marginal cilia do not have true bulbae, being only occasionally enlarged and spreading to from a thick and massive marginal black line.

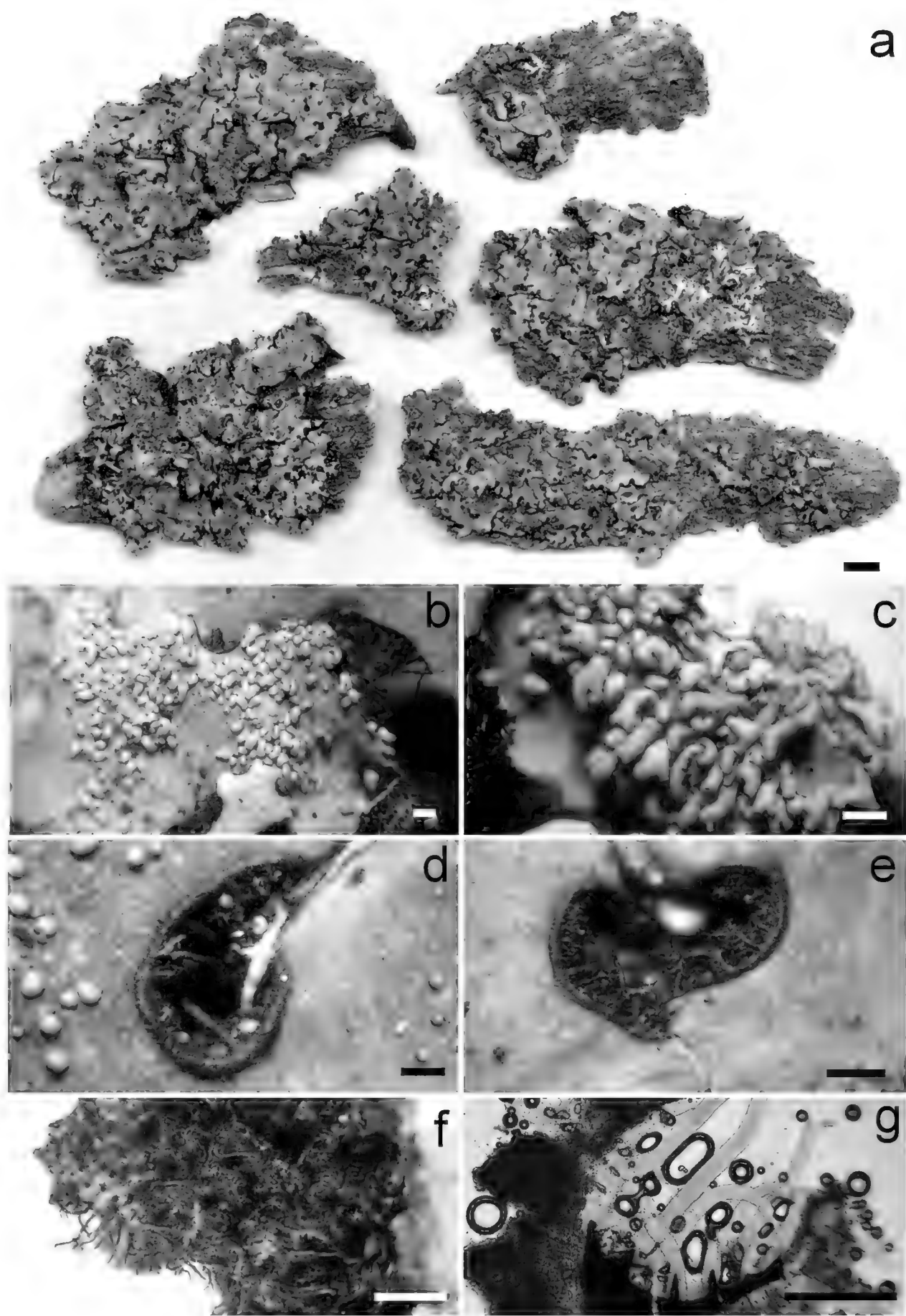


FIGURE 3. The holotype of *Parmotrema yunnanum* (HMAS).
a - thallus; b-c - detail of lacinules; d - the massive black marginal line;
e - cilia; f - rhizines; g - detail of the cilia.
Bars: a = 5mm; b-g = 0.5 mm

The prominent black margin in this species has a different origin from bulbae, probably due to an excessive growth of the lower cortex, rather than the coalescence of adjacent bulbae, which sometimes leads to the formation of a very thick black margin in some species of *Bulbothrix* (particularly those with mainly axillary cilia).

Bulbothrix suffixa was compared to *B. yunnana* (Wang et al. 2000), since it also forms laminal lacinules. It bears cilia with distinctly inflated bulbae, lacinules with bulbate cilia, and the presence of medullary gyrophoric acid.

Bulbothrix suffixa (BM! holotype, GLAM! isotype) has narrower, dichotomously branched laciniae (0.3–0.9 mm wide), as well as branched cilia and rhizines. However, this species does not produce laminal lacinules (we have seen only some few adventitious, marginal lacinulae) and the type does have what appear to be vestigial, laminal isidia.

Bulbothrix lopezii differs in having prominent bulbate cilia with short, simple apices, short, simple rhizines, flat, dichotomously branched, laminal lacinules, smaller and more rounded ascospores (3.0–6.0 µm long), and an absence of medullary caperatic and secalonc acids (*B. lopezii* only contains traces of fatty acids).

No other *Parmotrema* species, even among those formerly included in *Canomaculina* and *Rimeliella*, shares the characteristics of *P. yunnanum*, in particular, the laminal lacinules, squarrose cilia and rhizines and the lack of positive medullary spot tests.

Acknowledgments

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Literature cited

- Blanco O, Crespo A, Divakar PK, Elix JA, Lumbsch HT. 2005. Molecular phylogeny of parmotremaoid lichens (*Ascomycota*, *Parmeliaceae*). *Mycologia* 97(1): 150–159.
- Elix JA. 1993a. Progress in the generic delimitation of *Parmelia* sensu lato lichens (*Ascomycotina*: *Parmeliaceae*) and a synoptic key to the *Parmeliaceae*. *Bryologist* 96(3): 359–383.
- Elix, JA. 1993b. New species in the lichen family *Parmeliaceae* (*Ascomycotina*) from Australia. *Mycotaxon* 47: 101–129.
- Elix JA. 1997a. The lichen genera *Canomaculina* and *Rimeliella* (*Ascomycotina*, *Parmeliaceae*). *Mycotaxon* 65: 475–479.
- Elix JA. 1997b. Further new species in the lichen family *Parmeliaceae* (*Ascomycotina*) from Australasia. *Mycotaxon* 65: 481–491.

- Elix JA, Hale ME. 1987 *Canomaculina*, *Myelochroa*, *Parmelinella*, *Parmelinopsis* and *Parmotremopsis*, five new genera in the *Parmeliaceae* (lichenized *Ascomycotina*). *Mycotaxon* 29: 233–244.
- Feuerer T, Marth C. 1997. Anatomy of pseudocyphellae and bulbate cilia in *Parmeliaceae*. *Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg* 27: 101–107.
- Hale ME. 1965. Six new species of *Parmelia* from Southeast Asia. *Journal of Japanese Botany* 40(7): 199–205.
- Hale ME. 1972. *Parmelia jamesii*, an unusual species in Section *Imbricaria* (*Lichenes*) from Australia and New Zealand. *Phytologia* 23: 179.
- Hale ME. 1974. *Bulbothrix*, *Parmelina*, *Relicina*, and *Xanthoparmelia*, four new genera in the *Parmeliaceae*. *Phytologia* 28: 479–490.
- Hale ME. 1975. A monograph of the lichen genus *Relicina* (*Parmeliaceae*). *Smithsonian Contributions to Botany* 26: 1–32.
- Hale ME. 1976a. A monograph of the lichen genus *Parmelina* Hale (*Parmeliaceae*). *Smithsonian Contributions to Botany* 33: 1–60.
- Hale ME. 1976b. A monograph of the lichen genus *Bulbothrix* Hale (*Parmeliaceae*). *Smithsonian Contributions to Botany* 32: 1–29.
- Louwhoff SHJJ, Elix JA. 2000a. Five new species in the lichen family *Parmeliaceae* (*Ascomycotina*) from Grande Terre, New Caledonia. *Mycotaxon* 75: 195–203.
- Louwhoff SHJJ, Elix JA. 2000b. The lichens of Rarotonga, Cook Islands, South Pacific Ocean II: *Parmeliaceae*. *Lichenologist* 32(1): 49–55.
- Louwhoff SHJJ, Elix JA. 2002. *Hypotrachyna* (*Parmeliaceae*) and allied genera in Papua New Guinea. *Bibliotheca Lichenologica*, 81. J. Cramer, Berlin, Stuttgart. 149 pp.
- Sipman HJM. 1993. Lichens from Mount Kinabalu. *Tropical Bryology* 8: 281–314.
- Streimann H. 1986. Catalogue of the lichens of Papua New Guinea and Irian Jaya. *Bibliotheca Lichenologica* 22. J. Cramer, Berlin and Stuttgart. 145 pp.
- Wang SL, Chen JB, Elix JA. 2000. New species of *Parmeliaceae* (lichenized *Ascomycotina*) from China. *Mycotaxon* 76: 293–298.

***Botryobasidium sassofratinoense* sp. nov.
(*Cantharellales*, *Basidiomycota*) from Italy**

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Abstract — *Botryobasidium sassofratinoense* is described as new cystidiate species from Riserva of Sasso Fratino, located in Emilia-Romagna Region in the northern part of Italy. A key to the cystidiate species of *Botryobasidium* is provided and the new species is compared with the most closely related species, *B. ansosum* and *B. pilosellum*.

Key words — taxonomy, wood-inhabiting fungi, *Abies alba*, Europe

Introduction

During the revision of material present in HUBO herbarium, a nameless specimen fell into the hands of one of the authors (A.B.), and on its envelope was written: “This could be a nice species!” After a close look the collection turned out to represent a cystidiate *Botryobasidium* close to *B. ansosum* (H.S. Jacks. & D.P. Rogers) Parmasto and to *B. pilosellum* J. Erikss. but with some different microscopic characters. It seemed quite surprising to discover a new species in a reserve that had been so well investigated during the last 25 years (with 545 macrofungi recorded from that area; Bernicchia & Gorjón 2009), and where two other new species had been described so recently: *Fomitopsis labyrinthica* Bernicchia & Ryvarden (Bernicchia & Ryvarden 1996) and *Ceriporiopsis guidella* Bernicchia & Ryvarden (Bernicchia & Ryvarden 2003). What is even more intriguing is that all three new species were recorded along the same trail that goes from Pian del Pero to Rio Cullacce inside Sasso Fratino Natural Reserve.

The genus *Botryobasidium* Donk belongs to the fungal order *Cantharellales* (*Homobasidiomycetes*) and about 50 species are recognized (CBS 2009, Langer 1994, Parmasto et al. 2004). *Botryobasidium* is a saprobic genus with corticioid to hypochnoid resupinate basidiocarps and diagnostic basidia that are short, cylindrical or subcylindrical to suburniform with 2–8 sterigmata, and generally arranged in clusters. *Botryobasidium* shows clear relations with *Thanatephorus*, *Ceratobasidium*, and *Ceipomyces*, in which basidiospores generally grow by repetition; it is also related to *Sistotrema*, which differs in the nature of the hymenium (palisade in *Sistotrema* and clustered in *Botryobasidium*) and shape of basidia (urniform in *Sistotrema* and subcylindrical to suburniform in *Botryobasidium*). Molecular data have confirmed these relationships, placing *Botryobasidium* in the cantharelloid clade as a sister taxon of *Sistotrema*, *Cantharellus*, *Craterellus*, *Hydnum*, and *Clavulina* (Moncalvo et al. 2006).

Material and methods

For light microscopic studies, samples were mounted in 3% potassium hydroxide (KOH) and Melzer's solution (IKI). Thirty basidiospores have been measured to calculate the mean length and width and the following abbreviations are used: L^* = mean spore length, W^* = mean spore width, Q^* = quotient of the spore length and width (L^*/W^*). Specimens are deposited in HUBO.

Species description

***Botryobasidium sassofratinoense* Bernicchia & G. Langer, sp. nov.** FIGS. 1,2

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Carposomata annua, resupinata, tenuissima, effusa, levia vel hypochnoidea, subalbida vel cremeo-alba. Systema hypharum monomiticum: hyphae generativae erectae, hyalinae, fibulatae angulo recto ramosae; tenuitunicatae 5–8(–9) μ m latae in subhymenio, leviter crassitunicatae, 10–12(–15) μ m latae in subicolo. Cystidia rara, subcylindracea, pleraque tenuiter tunicata, 28–45(–55) μ m longa et 5–7 μ m lata. Basidia subcylindracea vel suburniformia, leviter constricta, cum fibula basali, (13–)18–25 μ m longa et 6–8.5 μ m lata, 6-sterigmatibus recurvis. Basidiosporae hyalinae, tenuiter tunicatae, leves, navicularum figura, saepe quaternibus se congregatae, (6–)7–8.5 μ m longae, (3–)3.5–4.5 μ m latae, inamyloideae.

HOLOTYPE: Italia, Forlì-Cesena, Riserva Integrale di Sasso Fratino, loc. Rio Cullacce, 950 m. leg. A. Bernicchia 27.09.2001, in ligno putrido *Abies alba*, coll. 7594 in herbario HUBO conservatus est. Isotypus in K.

ETYMOLOGY: the specific epithet derives from the name of the collecting area, Riserva di Sasso Fratino.

DESCRIPTION — **BASIDIOMATA** annual, resupinate, effuse, very thin, smooth to arachnoid, whitish to pale ivory, 150–200 μ m thick, margin indistinct and not differentiated. **HYPHAL SYSTEM** monomitic: generative hyphae clamped and smooth, thin-walled, branched at right angles, 5–8(–9) μ m wide in

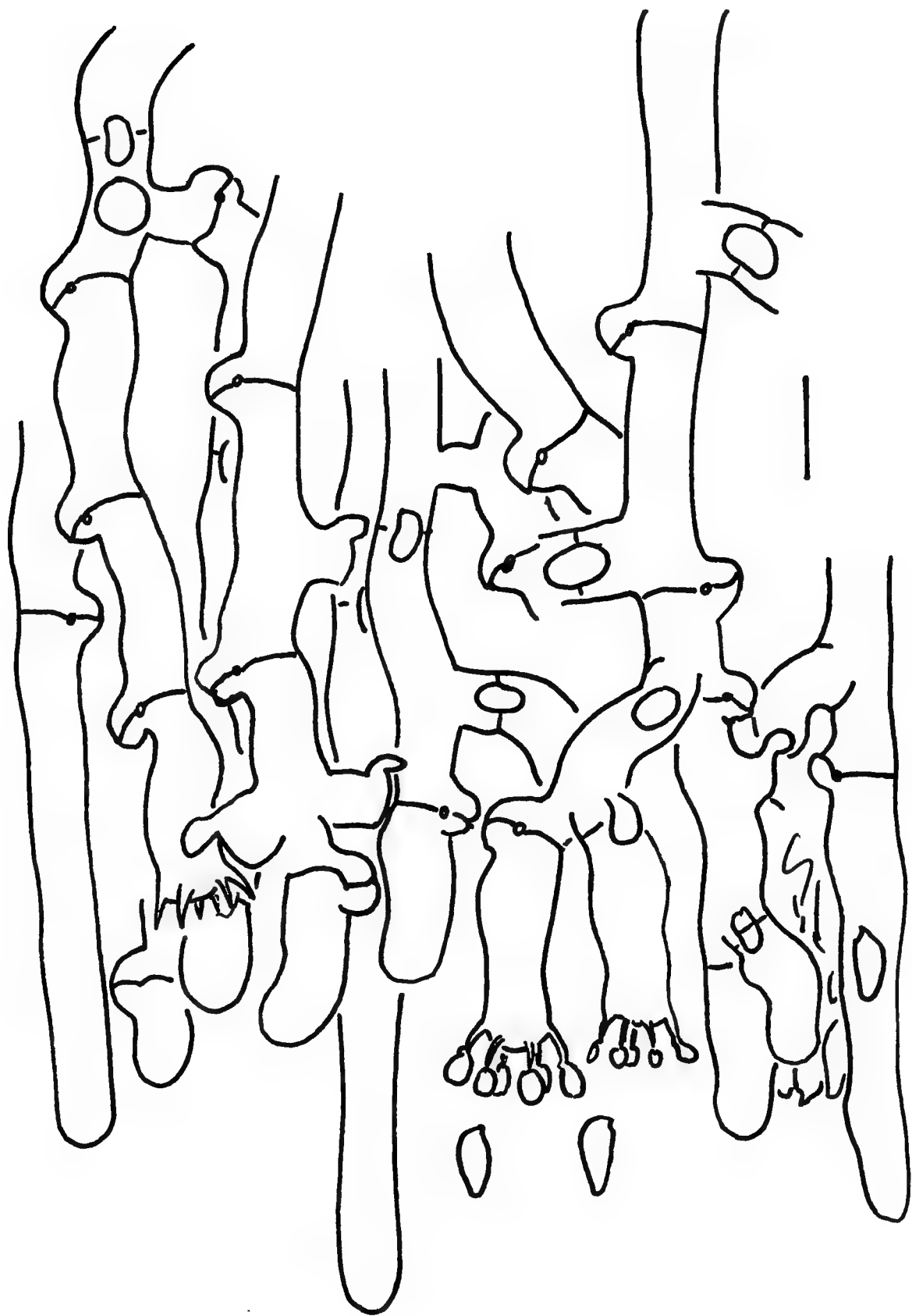


FIG. 1. *Botryobasidium sassofratinoense* (coll. A. Bernicchia 7594)
Hymenial elements. Bar=10 µm



FIG. 2. *Botryobasidium sassofratinoense* (coll. A. Bernicchia 7594)
Basidia and basidiospores. Bar=10 μm above, 5 μm below

subhymenium, slightly thick-walled in subiculum, 10–12(–15) μm wide and slightly yellowish near to the substrate. CYSTIDIA tubular, not frequent, basally clamped, hyaline, smooth, thin-walled, apically obtuse, 28–45(–55) \times 5–7 μm , without additional septa (Figure 1). BASIDIA arranged in botryose clusters, suburniform to subcylindrical, slightly constricted, smooth, thin-walled, basally clamped, (13–)18–25 \times 6–8.5 μm , usually with 6 slender sterigmata up to 2.5–3.5(–4) μm long (Figure 2). BASIDIOSPORES navicular (Figure 2), hyaline, smooth, thin-walled, mostly glued together in groups of four, IKI–, (6–)7–8.5 \times (3–)3.5–4.5 μm , with apiculus bent towards ventral side, $L^* = 7.7$, $W^* = 3.9$, $Q^* = 1.97$. Chlamydospores and anamorph not found.

DISTRIBUTION AND ECOLOGY — Thus far *Botryobasidium sassofratinoense* is known only from the type locality growing on well-decayed *Abies alba* wood. The area is a 764.25 ha Natural Reserve located in the northern Apennines (43°49'59"N, 11°49'E). It has a humid oceanic to subcontinental bioclimate (Gonnelli & Bottacci 2009), where *Fagus sylvatica* is the dominant species with well preserved areas of *Abies alba*, *Acer pseudoplatanus*, *Ulmus glabra*, *Fraxinus excelsior*, *Taxus baccata*, *Quercus cerris*, *Q. petraea*, *Ostrya carpinifolia*, *Carpinus betulus*, and *Corylus avellana* the most significant.

REMARKS — *Botryobasidium sassofratinoense* belongs to the group of cystidiate and clamped *Botryobasidium* species. Of these, *B. baicalinum* Kotir. & Ryvarden and *B. parvisetosum* Boidin & Gilles produce subglobose chlamydospores and very long, two-celled cystidia (Boidin & Gilles 1998, Kotiranta & Ryvarden 2007). *Botryobasidium grandinioides* Hallenb. has a grandinioid to aculeate basidiome with longer, densely encrusted cystidia. *Botryobasidium ansosum* is distinguished by longer, wider cystidia and basidiospores, and *B. pilosellum* has shorter basidiospores and longer encrusted cystidia. Moreover, the former two species and *B. sassofratinoense* also differ from *B. grandinioides* in the hypochnoid to arachnoid hymenophore. TABLE 1 compares some diagnostic characters of related species and *B. sassofratinoense*.

Key for the cystidiate species of *Botryobasidium*

- 1a. With chlamydospores, two-celled cystidia 2
- 1b. Without chlamydospores, cystidia different 3
- 2a. Cystidia 50–90 µm long, basidiospores 7.2–9.2 × 2.2–3 µm *B. parvisetosum*
- 2b. Cystidia > 100 µm long, basidiospores 7–8 × 2.7–3.4 µm *B. baicalinum*
- 3a. Hyphae with clamps 4
- 3b. Hyphae without clamps 7
- 4a. Basidiome grandinioid to aculeate *B. grandinioides*
- 4b. Basidiome smooth or hypochnoid to arachnoid 5
- 5a. Hyphae/cystidia with incrustation, basidiospores (4.5–)5–6 × 2.5–3 µm
..... *B. pilosellum*
- 5b. Hyphae/cystidia without incrustation, basidiospores (6–)7–10 × (3–)3.5–5 µm .. 6
- 6a. Cystidia 50–120 × 8–12 µm, basidiospores 8–10 × 4–5 µm *B. ansosum*
- 6b. Cystidia 28–45(–55) × 5–7 µm, basidiospores (6–)7–8.5 × (3–)3.5–4.5 µm
..... *B. sassofratinoense*
- 7a. Basidia 8–13 × 5–6 µm, basidiospores 4.5–7 × 2–3 µm *B. piliferum*
- 7b. Basidia and basidiospores larger 8
- 8a. Basidia 17–22 × 9–10.5 µm, basidiospores 10–11.5 × 4–5.5 µm *B. digitatum*
- 8b. Basidia 15–18(–20) × 6–8 µm, basidiospores 7.5–8.5 × 3–4 µm *B. tubulicystidium*

TABLE 1. Comparison of related *Botryobasidium* species with *B. sassofratinoense* (all measures in µm).

SPECIES	CLAMPS	CYSTIDIA	BASIDIA	BASIDIO-SPORES	HYMENOPHORE	ENCRUSTATION	DISTRIBUTION	SUBSTRATE
<i>ansosum</i>	constant	50–120 × 8–12	17–29 × 7–10	8–9(–10) × 4–5	hypochnoid to pilosa	none	North America	conifer wood, especially <i>Pinus</i> , <i>Picea</i>
<i>digitatum</i>	absent	60–125 × 6–9	17–22 × 9–10.5	10–11.5 × 4–5.5	pruinose to arachnoid	none	Panama	wood (burned)
<i>grandinioides</i>	constant	up to 200 × 9–10	15–16(–19) × 5.5–7	6–7(–9) × 3–4	hypochnoid to grandinioid	strong	Iran	wood
<i>piliferum</i>	absent	40–100 × 6–8	(8–)9–13 × 5–6	4.5–7 × 2–3	arachnoid to hypochnoid	none	Africa	wood
<i>pilosellum</i>	constant	65–100 × 4–9	15–20 × 5–6.5	(4.5–)5–6 × 2.5–3	hypochnoid	slight	Ukraine	conifer wood
<i>sassofratinoense</i>	constant	28–45(–55) × 5–7	(13–)18–25 × 6–8.5	(6–)7–8.5 × (3–)3.5–4.5	smooth to hypochnoid	none	Italy	conifer wood, <i>Abies alba</i>
<i>tubulicystidium</i>	absent	60–110 × 6–9	15–18(–20) × 6–8	7.5–8.5 × 3–4	arachnoid	none	Taiwan	wood

Acknowledgments

We are grateful to Patrizia Tabaroni and Giovanni Consiglio (Italy) for the revision of the Latin diagnosis, the members of State Forest Corp of Pratovecchio and Badia Prataglia (Arezzo) who, over the years have guided and helped during forays in Riserva of Sasso Fratino, and Heikki Kotiranta (Finland) and Erast Parmasto (Estonia) for their critical reviews of the manuscript before submission.

Literature cited

- Bernicchia A, Gorjón SP. 2009. La biodiversità fungina nella riserva naturale integrale di Sasso Fratino. 115–136, in Bottacci A (ed.). La Riserva naturale integrale di Sasso Fratino: 1959–2009. 50 anni di conservazione della biodiversità. CFS/UTB.
- Bernicchia A, Ryvarden L. 1996. Two new brown rot polypores from Italy. *Mycol. Helvetica* 8(2): 3–10.
- Bernicchia A, Ryvarden L. 2003. A new white-rot polypore from Italy. *Mycotaxon* 88: 219–224.
- Boidin J, Gilles G. 1998. Basidiomycètes *Aphylllophorales* de l'île de la Réunion X. Compléments aux genres traits antérieurement. *Bull. Soc. Mycol. France* 104: 59–72.
- CBS. 2009. *Aphylllophorales* database. www.cbs.knaw.nl/databases/index.htm.
- Gonnelli V, Bottacci A. 2009. Il clima di Sasso Fratino. 39–45, in Bottacci A (ed.). La Riserva naturale integrale di Sasso Fratino: 1959–2009. 50 anni di conservazione della biodiversità. CFS/UTB.
- Kotiranta H, Ryvarden L. 2007. *Botryobasidium baicalinum* sp. nova (*Aphylllophorales*, *Basidiomycetes*). *Ann. Bot. Fennici* 44: 293–297.
- Langer G. 1994. Die Gattung *Botryobasidium* Donk (*Corticaceae*, *Basidiomycetes*). *Bibliotheca Mycologica*, Band 158. J. Cramer. Berlin. Stuttgart.
- Moncalvo JM, Nilsson RH, Koster B, Dunham SM, Bernauer T, Matheny PB, Porter TM, Margaritescu S, Weiss M, Garnica S, Danell E, Langer G, Langer E, Larsson E, Larsson KH, Vilgalys R. 2007. The cantharelloid clade: dealing with incongruent gene trees and phylogenetic reconstruction methods. *Mycologia* 98: 937–948.
- Parmasto E, Nilsson RH, Larsson KH. 2004. Cortbase version 2. Extensive updates of a nomenclatural database for corticioid fungi (*Hymenomycetes*). *Phyloinformatics* 1: 5.

New data on puffballs (*Agaricomycetes*, *Basidiomycota*) from the Northeast Region of Brazil

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Abstract — In order to increase the knowledge of puffballs in Brazil, specimens were collected in the State of Pernambuco, an understudied area in the Northeast Region, between June 2008 and April 2009. *Arachnion album*, *Bovista dominicensis*, and *Morganella fuliginea* are recorded for the first time from this region. *Bovista grandipora*, collected on soil among grass, is described as a new species in the *Bovista delicata*-complex. This species is characterized by a thin whitish exoperidium, an olive-brown endoperidium, punctate to verruculose, apedicellate basidiospores (4–5.5 µm diam.), and capillitium of the *Lycoperdon*-type with large pits in the hyphal units. Descriptions and illustrations, including SEM micrographs of basidiospores, are presented for each of the identified species, and keys to the recorded species of *Arachnion*, *Bovista*, and *Morganella* from Brazil are also provided.

Key words — *Lycoperdales*, gasteromycetes, Neotropical mycobiota

Introduction

Puffballs are gasteroid fungi, usually oval to pyriform in shape, having a peridium that encloses a mass of spores. The basidiospores, along with other elements (e.g., capillitial threads), comprise the gleba, and as the puffball matures a large number of basidiospores can be released through an apical opening (ostiole) or as the peridium disintegrates (Pegler et al. 1995). These species are generally saprobic, terricolous and humicolous; however, a few (e.g. *Morganella* spp.) grow on decomposing wood (Bates 2004).

The true puffballs were traditionally members of *Lycoperdales*, within in families such *Arachniaceae*, *Lycoperdaceae*, and *Mesophelliaceae* (Miller & Miller 1988). Recently, molecular studies have altered the taxonomic arrangement for this basidiomycetous group, and these species are now placed within the *Agaricales*, in the family *Agaricaceae* (Kirk et al. 2008).

The Northeast Region of Brazil comprises nine states and covers an area of nearly 1,560,000 square kilometres (IBGE 2009), an area larger than the territories of Spain, France and Germany combined. Despite the large territorial area and wide assortment of vegetation types, from tropical rainforests to savanna-like vegetation, only a few puffball species are recorded from this region: i.e., *Bovista aestivalis* (Bonord.) Demoulin, *B. pila* Berk. & M.A. Curtis, *B. plumbea* Pers., *B. pusilla* (Batsch) Pers., *Calvatia cyathiformis* (Bosc) Morgan, *C. maxima* (Schaeff.) Morgan, *C. rugosa* (Berk. & M.A. Curtis) D.A. Reid (= *C. rubroflava* (Cragin) Lloyd), *C. sculpta* (Harkn.) Lloyd, *Lycogalopsis solmsii* E. Fisch., and *Lycoperdon perlatum* Pers. (Baseia 2005a, b; Trierveiler-Pereira & Baseia 2009).

This study aims to contribute to the knowledge of gasteroid fungi in the Northeast Region of Brazil. Here we report on four new records of puffballs from the region, one of which is described as a new species.

Materials and methods

Field expeditions were carried out from June 2008 to April 2009 in five remnants of the Atlantic rainforest in the State of Pernambuco, Brazil: Parque Estadual Dois Irmãos (08°00'13"S, 34°56'59"W), Reserva Ecológica de Carnijós (08°08'42"S, 35°04'34"W), Refúgio Ecológico Charles Darwin (07°49'S, 34°56'W), Parque Ecológico João de Vasconcelos Sobrinho (08°22'06"S, 36°01'57"W), Mata do Estado (07°37'21"S, 35°30'19"W); and at the Campus of the Federal University of Pernambuco (08°02'55"S, 34°57'08"W), in the city of Recife.

Macroscopic characters were described based on observations of fresh and dried material, according to Miller & Miller (1988). Colors were determined according to Kornerup & Wanscher (1978). Observations of microscopic characters were made under a light microscope on glass slides mounts (in 5% KOH or Lactophenol Cotton Blue) prepared by taking a small portion of glebal or peridial material from dried specimens. Thirty randomly selected basidiospores were measured under the light microscope at 1000× to determine the range in spore dimensions.

Scanning electron microscopy (SEM) studies were conducted at the Centro de Tecnologias do Gás (CTGÁS) in Natal (RN), Brazil. Sections were removed from dried basidiomata and dusted onto specimen holders attached with double-sided carbon adhesive tape and then coated with up to 15 angstroms of gold-palladium on an Ion Sputter Coater to prepare for scanning electron microscopy (SEM).

Relevant literature (Kreisel 1967, Demoulin 1971, Suárez & Wright 1996, Kasuya et al. 2006) was used in the identification of the material examined, and voucher specimens are preserved in URM (Holmgren & Holmgren 1998).

Taxonomy

Arachnion album Schwein., Schriften Naturf. Ges. Leipzig 1: 59 (1822). FIGS 1–4
Basidiomata globose to subglobose (FIG.1), 8–27 mm diam., attached at the base with a whitish mycelia rhizomorph (to 7 mm in length) (FIG. 2). Peridium thin, fragile, white when fresh, golden (4C6) after drying, smooth; dehiscence irregular. Gleba grayish green (1D4), composed of peridioles resembling minute sand grains (FIG. 3). Subgleba absent. Basidiospores ovoid to subglobose (FIG. 4), 4–5(–5.5) × 3–4(–4.5) µm, smooth, hyaline to greenish in KOH, slight thick-walled, with a single oil drop; pedicels typically short, up to 1 µm, occasionally with a long (to 27 µm) sterigmal remnant still attached. Capillitium and paracapillitium absent.

HABITAT — growing on soil among grass.

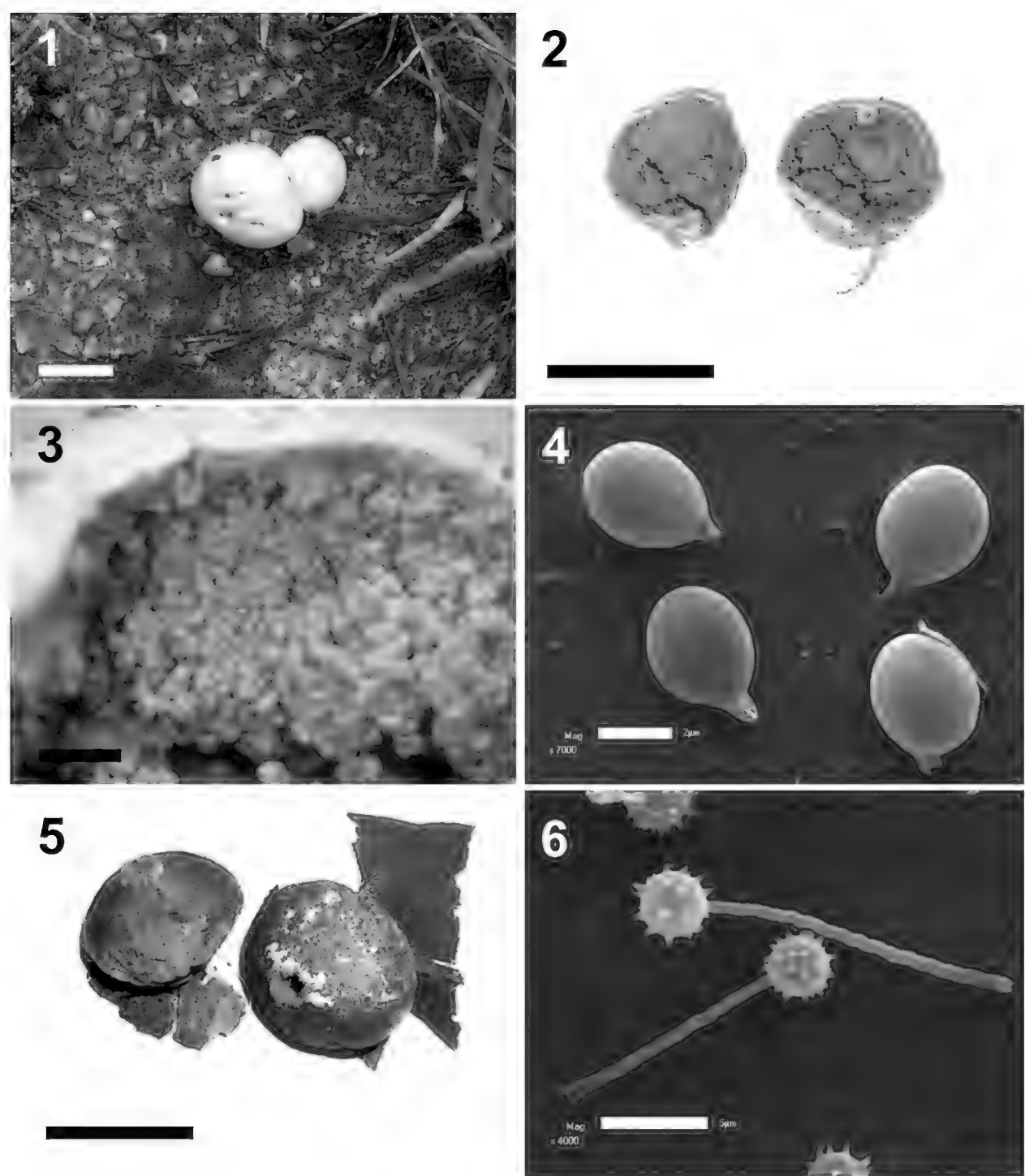
KNOWN DISTRIBUTION — widely distributed throughout the world.

SPECIMEN EXAMINED — BRAZIL. PERNAMBUCO: Recife. Campus da Universidade Federal de Pernambuco. col. L. Trierweiler-Pereira & V.R. Coimbra. 02.III.2009 (URM 80075).

TAXONOMIC REMARKS — According to Kasuya et al. (2006), this species resembles *A. drummondii* Berk., *A. iulii* Quadr., and *A. tenerum* (Berk.) Long; however, these can be separated based on basidiospore morphology, coloration of the gleba, and characteristics of the hyphae associated with the peridiole. The description of *A. iriema*e Rick, based on Brazilian material, suggests a puffball that is very close to *A. album*. Rick (1961) separated these species primarily by peridial characteristics (e.g., color, degree of fragility), which can vary as the puffball matures. Although the species may represent a synonym of *A. album*, confirmation of this fact awaits re-examination of the holotype, and it is treated separately here in the key. Four *Arachnion* species are recorded from Brazil and the range of the genus has, thus far, been restricted to the southern parts of the country (Trierweiler-Pereira & Baseia 2009).

Key to the *Arachnion* species recorded from Brazil

- 1a. Peridium finely warted, pale yellowish when fresh *A. scleroderma*
- 1b. Peridium smooth, white, grayish or brownish when fresh 2
- 2a. Peridioles white; peridium brownish, odor fetid *A. foetens*
- 2b. Peridioles gray to grayish green; peridium white to gray; odor not fetid 3
- 3a. Peridium grayish, extremely fragile, even in fresh specimens *A. iriema*e
- 3b. Peridium whitish, gradually becoming more fragile with age *A. album*



FIGURES 1–6. 1–4. *Arachnion album*. 1. Mature basidiomata in situ (scale bar = 2 cm). 2. Mature basidiomata in longitudinal section (scale bar = 2 cm). 3. Peridioles (scale bar = 0.5 mm). 4. SEM of basidiospores (scale bar = 2 µm). 5–6. *Bovista dominicensis*. 5. Mature basidiomata (scale bar = 2 cm). 6. SEM of basidiospores (scale bar = 5 µm).

Bovista dominicensis (Masse) Kreisel, Feddes Repert. 69: 202 (1964). Figs 5–6,13C
Basidiomata globose, depressed-globose to pyriform, 15–23 mm broad and 12–26 mm high (FIG. 5), base extended into a very small stipitoid part (2–4 mm broad and 3–6 mm high), with ramified whitish rhizomorphs (to 42 mm length). Exoperidium thin, light brown (6D4) to brownish orange (6C3), and

brown (6E7) toward the apex, composed of small, acute granules, appearing somewhat areolate at the apex, but becoming granulose-furfuraceous toward the base. Endoperidium thin, papery, opaque, pale red (7A3) to orange-white (6A2); opening at the apex by a ostiole circular to lobulate, ca. 5 mm diam. Gleba yellowish brown (5E8), powdery to floccose, spore print grayish brown, without an olivaceous tint. Subgleba compact, white, poorly developed. Basidiospores globose, 3.8–4.3 μm diam., verrucose-spinulose, ornamented with scattered hyaline short acute spines or conical warts (FIG. 6, 13C), pale olive-brown in KOH; pedicels long, 10–21 \times 1 μm , hyaline, straight and not tapering at the base. Capillitium of the *Lycoperdon*-type; capillitial threads up to 4.5 μm in diam., brownish in KOH, elastic, slightly thick-walled, lacking pits, partly encrusted with a hyaline amorphous substance, dichotomously branched, finely extended at the tips, frequently breaking irregular or rectangular; septa rare, true or false when occurring. Paracapillitium not observed.

HABITAT — growing on decomposing leaves and woody debris.

KNOWN DISTRIBUTION — Neotropical.

SPECIMEN EXAMINED — BRAZIL. PERNAMBUCO: Igarassu. Refúgio Ecológico Charles Darwin. col. J. Pereira. 17.VII.2008 (URM 80076).

TAXONOMIC REMARKS — This species is morphologically similar to *B. trachyspora* (Lloyd) Kreisel and *B. longissima* Kreisel as these have long pedicellate spores, *Lycoperdon*-type capillitium that is lacking pits, and lack a subgleba (Kreisel 1967). The basidiomata of *B. trachyspora* are typically smaller (usually 10 mm diam.), while those of *B. dominicensis* are larger (reaching 25 mm diam.). Microscopically, the basidiospores of *B. trachyspora* have pedicels that are shorter (to 11 μm in length) than those of *B. dominicensis* (to 38 μm in length). Reports of *B. dominicensis* are rare in Brazil, and so far it was only recorded from two states: Rio Grande do Sul and Espírito Santo (Trierveiler-Pereira & Baseia 2009). This is the first record of *B. dominicensis* from the Northeast Region of Brazil.

Bovista grandipora Trierveiler-Pereira, Kreisel & Baseia, sp. nov. FIGS 7–10, 13G

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*Basidiomata globosa vel subglobosa, 9–24 mm lata, basi funiculis mycelialibus albidis praedita, sine subgleba. Exoperidium tenue, candidum, deinde luteolum, areolatum, glabrum, deinde furfuraceo-areolatum, stratum exterius praecipue hyphis flexuosis compositum, cellulis vesiculososis sparse intermixtis. Endoperidium brunnescens, ore irregulari ad 5 mm amplo dehiscens. Gleba olivaceobrunnea, sine pseudocolumella. Sporae globosae, 3.5–4.5 μm diam., punctatae vel verruculosae, in cumulo olivaceobrunneae, apedicellatae, rudimentis pedicellorum hyalinis, 1–6 μm longis. Capillitium modo generis *Lycoperdinis* ramificatum; hyphae principales 2.0–6.5 μm crassae, olivaceo-luteolum vel brunneolum, fragile, poris numerosis, conspicuis, ellipticis, 0.5–2 μm latis, dichotomum; septis veribus sparsis praeditum. Paracapillitium nullum. Ad terram.*

HOLOTYPE — *Brasilia, Pernambuco, Recife; in herbarium URM conservatus est (URM 80036).*

ETYMOLOGY — (Lat.) *grandis* = large, conspicuous; *porus* = pit (refers to capillitial threads).

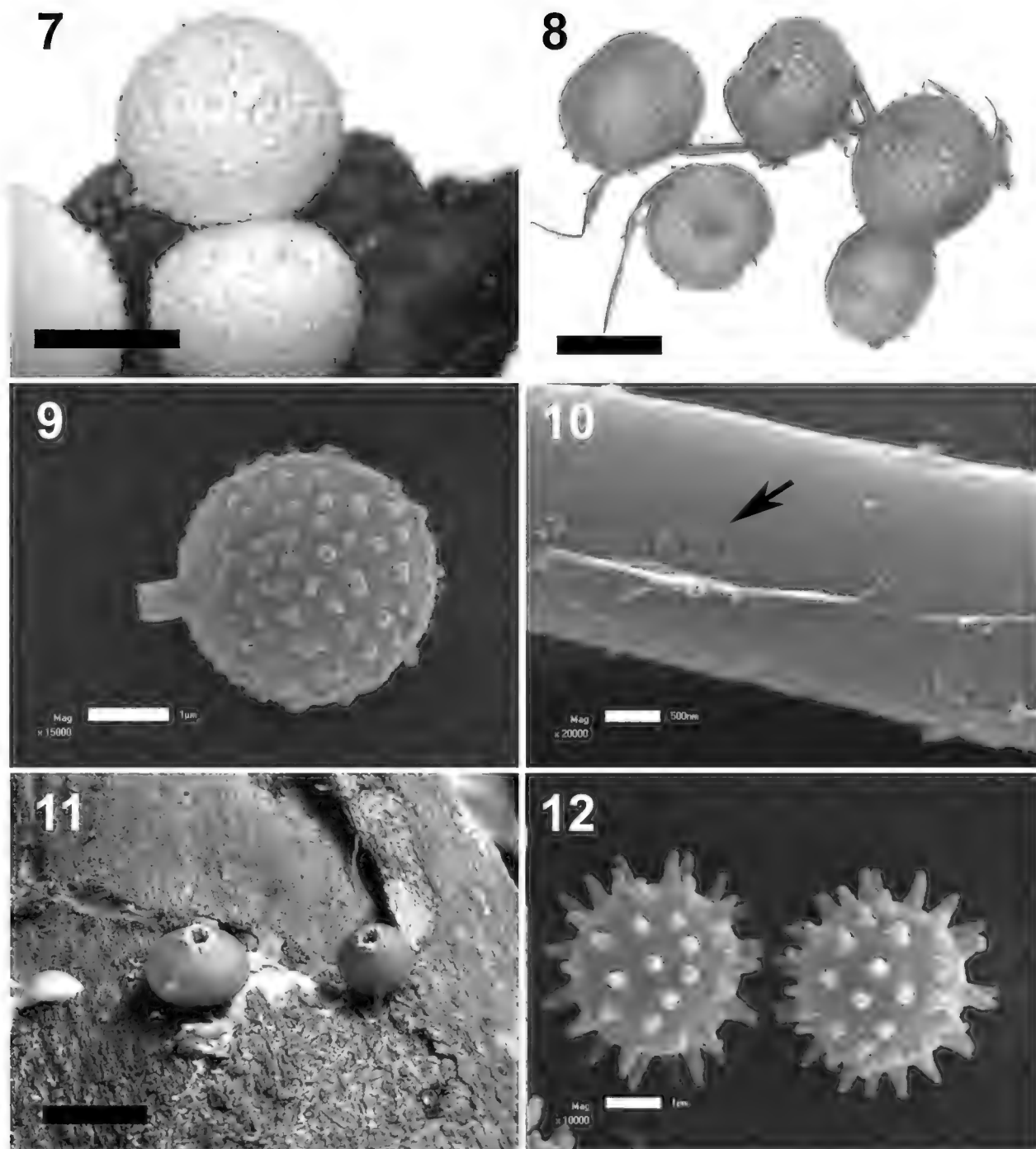
Basidiomata globose, subglobose to depressed globose, 9–24 mm broad and 5.5–21 mm high (FIGS 7,8), with whitish to grayish rhizomorphs (to 13 mm length). Exoperidium very thin, white, yellowish white (4A2) to pastel yellow (1A4), smooth to furfuraceous, usually as whitish patches over the endoperidium at maturity, or disappearing completely; exostratum composed primarily of hyaline, septate hyphae and sparsely scattered pseudoparenchymatous cells, mycosclereids absent. Endoperidium thin, papery, light yellow (2A5) to yellow (3B8) when young, later greenish yellow (1B4), olive (3D5), to olive-brown (4D6); ostiole small, irregular in shape, up to 5 mm in diam; Gleba white at first, turning olive-brown (4D5), powdery; pseudocolumella absent. Subgleba absent. Spore print olive green, olive-brown to light brown. Basidiospores globose, 3.5–4.5 μm in diam., punctate to finely verruculose (FIGS 9, 13G), pale olive yellow in KOH; pedicels hyaline, short (typically 1 μm length, some reaching 4–6 μm) or completely lacking. Capillitium of the *Lycoperdon*-type; capillitial threads 2–6.5 μm in diam., pale olive-brown in KOH, very fragile, slightly thick-walled, with frequent large (0.5–2.0 μm in diam) elliptical pits (FIG. 10), dichotomously branched; septa true, false septa not observed. Paracapillitium lacking.

HABITAT — growing on soil among grass.

KNOWN DISTRIBUTION — Brazil, Puerto Rico, Dominican Republic, Cuba, USA, Spain, Nepal, India, Japan.

SPECIMENS EXAMINED — **BRAZIL. PERNAMBUCO: Recife.** Campus da Universidade Federal de Pernambuco. col. V.R. Coimbra & G. Melo. 04.II.2009 (*URM 80067*); same location, col. V.R. Coimbra & G. Melo. 04.II.2009 (*URM 80068*); same location, col. L. Trierveiler-Pereira & V.R. Coimbra. 02.III.2009 (*URM 80069*); same location, col. V.R. Coimbra & F. Wartchow. 13.IV.2009 (*URM 80070*); same location, col. V.R. Coimbra & F. Wartchow. 13.IV.2009 (*URM 80071*); same location, col. L. Trierveiler-Pereira & V.R. Coimbra. 14.IV.2009 (*URM 80072*); same location, col. L. Trierveiler-Pereira & V.R. Coimbra. 14.IV.2009 (*URM 80073*); same location, L. Trierveiler-Pereira & V.R. Coimbra. 14.IV.2009 (*URM 80074*).

ADDITIONAL MATERIAL EXAMINED BY H. KREISEL — **SPAIN. MÁLAGA: Fuengirola.** Castillomoro Sohails. col. J.A. Nannfeldt. 04.X.1957 (*UPS*); **NEPAL.** Dhanhutta, *Pinus roxburghii* forest, col. J.F. Dobremez, 10. 03.IX.1973 (*Herb. Kreisel*); **INDIA.** col S. Ahmad, 13. 1964 and 1965 (*NCU*); **JAPAN. HONSHU: Chiba.** Castillomoro Sohails. col. Y. Terashima no. Lp 1, 2, 3, 7, 9. 29.XI.2002 to 03.XII.2002 (*Herb. Kreisel*); **U.S.A. NORTH CAROLINE:** Chapel Hill. col. J.N. Couch. 22.VI.1922 (*NCU 511*); **FLORIDA: Gainesville.** Alachua Co. col. F.W. Walker. 11.VIII.1924 (*NCU*); **CUBA. LA HABANA: Calabazar.** col. F. Mazorra. 15.VII.1969 (*HAB 01178, dupl. in Herb. Kreisel*); **DOMINICAN REPUBLIC. LAS VEGAS: El Hatillo.** col. C.E. Chardon. 28.VIII.1937 (*NCU 1234a*); **PUERTO RICO. San Juan, Palominis Id.** col. C.E. Chardon. 14.X.1923 (*NCU*).



FIGURES 7–12. 7–10. *Bovista grandipora*. 7. Young basidioma (scale bar = 1 cm). 8. Mature basidiomata (scale bar = 1 cm). 9. SEM of basidiospore (scale bar = 1 µm). 10. SEM of capillitial thread (arrow = capillitial pit; scale bar = 0.5 µm). 11–12. *Morganella fuliginea*. 11. Mature basidiomata in situ (scale bar = 1.5 cm). 12. SEM of basidiospores (scale bar = 1 µm).

TAXONOMIC REMARKS — Macroscopically, *B. grandipora* is typified by basidiomata that grow on soil, have a thin, rather smooth whitish exoperidium (the exostratum being mainly hyphal) and olive-brown endoperidium, and lack a subgleba. Microscopically, the species is characterized by having a capillitium of the *Lycoperdon*-type, fragile capillitial threads with large pits and true septa, and apedicellate, globose, verruculose basidiospores. Although the description above is based on material from Brazil, this species is apparently widely

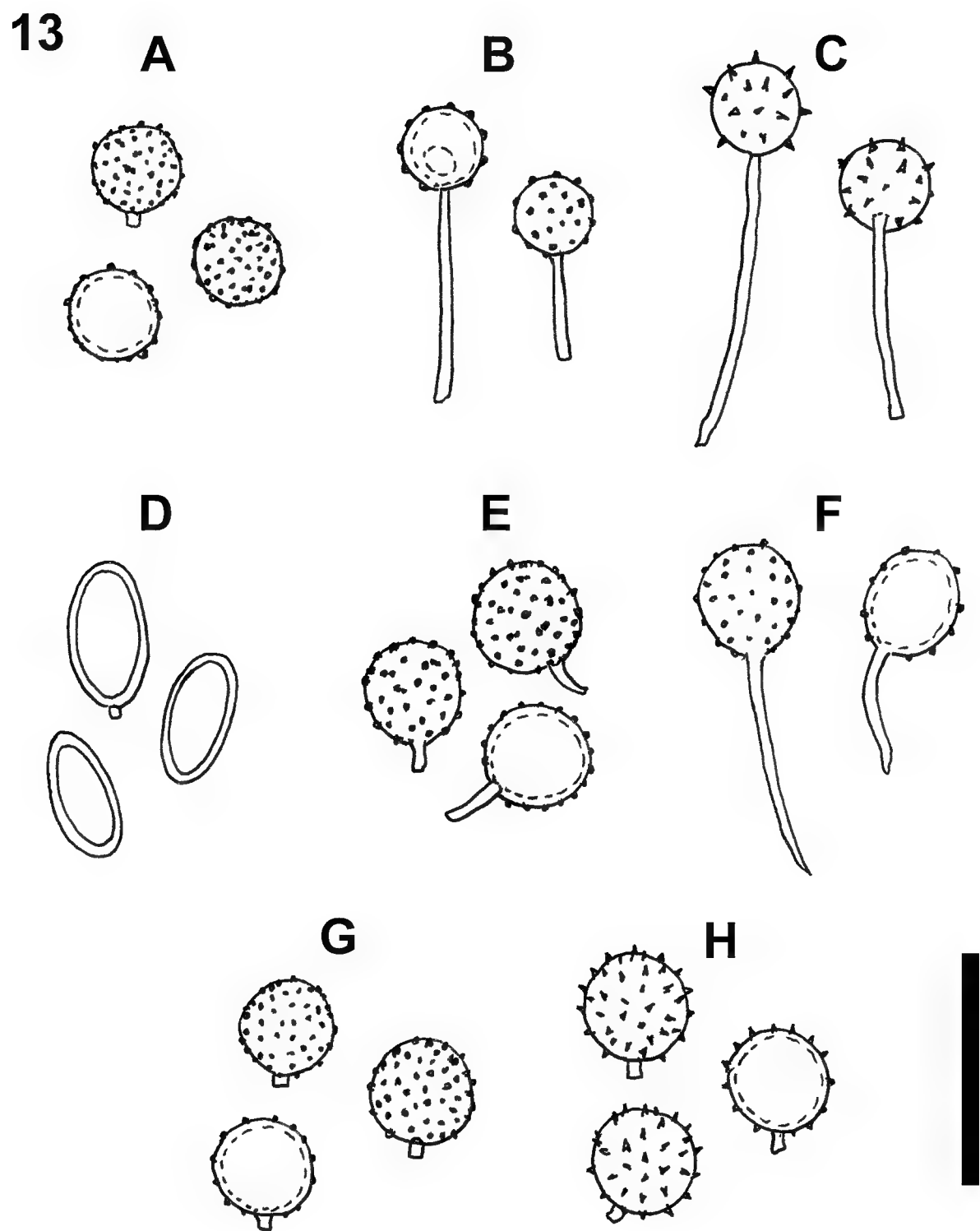


FIGURE 13 (scale bar = 10 μ m). Basidiospore of *Bovista* species recorded from Brazil. A. *B. aestivalis*. B. *B. africana*. C. *B. dominicensis*. D. *B. longispora*. E. *B. pila*. F. *B. plumbea*. G. *B. grandipora*. H. *B. pusilla*.

distributed in warmer regions (e.g., tropical, subtropical, and mediterranean to warm-temperate climates) including southern Europe and Asia, southeastern United States, the Caribbean, and South America.

B. grandipora belongs to *Bovista* ser. *Pusillae* Kreisel (Kreisel 1967). It is very close to *B. delicata* Berk. & M.A. Curtis, described from Hong Kong (type in K, PC), which has similar capillitial threads with frequent, large pits; however, it differs from the former by having distinctly pedicellate basidiospores (the pedicels 3–11 in length and somewhat bent). *Bovista pusilla* can be separated from *B. grandipora* as the former has capillitial threads with very small pits, frequent large ellipsoid to claviform cells in the exostratum and a more furfuraceous exoperidium. In a previous publication, Kreisel (1967) included collections of *B. grandipora* within *B. delicata*; however, study of fresh and abundant additional material (see above) indicated that the two taxa should be recognized as distinct species.

Some species in *Calvatia* sect. *Calvatia* (Kreisel 1967) are also characterized by capillitial hyphae with large pits, including the widespread *C. rugosa*; however, the basidiomata of these species are typically much larger. Pits in the capillitial hyphae of *Lycoperdaceae* species range from small to large, slit-like, or may even be lacking. To date, however, the biological function of these pits is not well understood.

Key to the *Bovista* species recorded from Brazil

- 1a. Capillitium of the *Lycoperdon*- or intermediate type 2
- 1b. Capillitium of the *Bovista*-type 7
- 2a. Capillitium of the intermediate type; capillitial threads with small pits ... *B. aestivalis*
- 2b. Capillitium of the *Lycoperdon*-type; capillitial threads with or without pits 3
- 3a. Subgleba present 4
- 3b. Subgleba absent 5
- 4a. Basidiospores globose, finely punctuate to verruculose, pedicels 4–16.5 µm in length *B. africana*
- 4b. Basidiospores long-ellipsoid, smooth; pedicels very short or absent *B. longispora*
- 5a. Capillitial threads lacking pits; basidiospores with long pedicels, 10–21 µm in length *B. dominicensis*
- 5b. Capillitial threads with pits; basidiospores with shorter pedicels, up to 6 µm in length 6
- 6a. Capillitial threads' pits small, up to 0.5 µm diam. *B. pusilla*
- 6b. Capillitial threads' pits large, up to 2 µm diam. *B. grandipora*
- 7a. Exoperidium light brown; basidiospores with short pedicels 1–2 µm in length *B. pila*
- 7b. Exoperidium grayish brown; basidiospores with longer pedicels, 6–14 µm in length *B. plumbea*

Morganella fuliginea (Berk. & M.A. Curtis) Kreisel & Dring, Feddes
Repert. 74: 113 (1967).

FIGS 11–12

Basidiomata pyriform, subglobose to depressed-globose, 8–21 mm broad and 6–12 mm high (FIG. 11), with a whitish rhizomorphs attached at the base. Exoperidium thin, at first dull lilac (15C3), grayish lilac (15B2) to lilac (16B3); and white toward the base, becoming reddish brown (8E6), dark brown (7F4) to brown (7E5), and orange (5A6) to pale orange (5A3) toward the base, covered by minute spines when young, becoming velutinous to smooth with maturity, or eventually disappearing; exostratum with spines composed by chains of pseudoparenchymatous cells that are +/- isodiametric, yellowish in KOH, thick-walled, 12–40 × 8–13 µm. Endoperidium thin, flaccid, beige (4C3); ostiole irregular in shape. Gleba grayish green (1C3), powdery. Subgleba pale yellow (1A3), composed of compacted cells. Basidiospores globose, (3.5–)4–5 µm in diam., echinate, slight thick-walled (FIG. 12), yellowish in KOH, with a single oil drop, pedicels absent. Eucapillitium absent. Paracapillitial threads 3–5 µm diam., pale yellow in KOH, thin to slightly thick-walled, lacking pits; septa true.

HABITAT — growing on decomposing wood.

KNOWN DISTRIBUTION — Pantropical.

SPECIMENS EXAMINED — BRAZIL. PERNAMBUCO: Moreno. Reserva Ecológica de Carnijós, col. L. Trierveiler-Pereira & J.M. Baltazar, 025. 17.VI.2008 (URM 80077); same location, col. L. Trierveiler-Pereira & J.M. Baltazar, 209. 12.III.2009 (URM 80082); CARUARU. Parque Ecológico João de Vasconcelos Sobrinho, col. L. Trierveiler-Pereira & J.M. Baltazar, 036. 20.VI.2008 (URM 80078); same location, col. L. Trierveiler-Pereira et al., 111. 12.VII.2008 (URM 80080); Recife. Parque Estadual Dois Irmãos, col. L. Trierveiler-Pereira et al., 056. 07.VII.2008 (URM 80079); same location, col. L. Trierveiler-Pereira et al., 175. 16.IX.2008 (URM 80081); São Vicente Férrer. Mata do Estado, col. L. Trierveiler-Pereira & J. M. Baltazar, 210. 19.III.2009 (URM 80083); same location, col. L. Trierveiler-Pereira & J. M. Baltazar, 211. 19.III.2009 (URM 80084).

TAXONOMIC REMARKS — The species is characterized by strongly echinate basidiospore, and exostratum with chains of pseudoparenchymatous cells. *M. fuliginea* is similar to *M. velutina* (Berk. & M.A. Curtis ex Masee) Kreisel & Dring; however, the latter is distinguished by the presence of setose, thick-walled hyphal elements in the exoperidium (Suárez & Wright 1996). In Brazil, *M. fuliginea* is currently the gasteroid species most widely distributed; being reported from seven states (Trierveiler-Pereira & Baseia 2009). This is the first record of *M. fuliginea* from the Northeast Region of Brazil.

Key to the *Morganella* species recorded from Brazil

- 1a. Eucapillitium present *M. pyriformis*
- 1b. Eucapillitium absent 2

- 2a. Basidiomata growing among dead leaves *M. benjaminii*
- 2b. Basidiomata growing on rotten wood or humus 3
- 3a. Exoperidium containing thick-walled, setose hyphal elements *M. velutina*
- 3b. Exoperidium lacking setose hyphal elements 4
- 4a. Basidiospores strongly echinate; exoperidium brownish lilac *M. fuliginea*
- 4b. Basidiospores asperate; exoperidium white to pale yellow *M. albina*

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Literature cited

- Baseia IG. 2005a. Some notes on the genera *Bovista* and *Lycoperdon* (*Lycoperdaceae*) in Brazil. *Mycotaxon* 91: 81–86.
- Baseia IG. 2005b. *Bovista* (*Lycoperdaceae*): dois novos registros para o Brasil. *Acta Botanica Brasilica* 19(4): 899–903.
- Bates ST. 2004. Arizona members of the *Geastraceae* and *Lycoperdaceae* (*Basidiomycota*, *Fungi*). Master Thesis, Arizona State University, U.S.A.
- Demoulin V. 1971. Observations sur le genre *Arachnion* Schw. (*Gasteromycetes*). *Nova Hedwigia* 21: 641–655.
- Holmgren PK, Holmgren NH. 1998. Index Herbariorum: A global directory of public herbaria and associated staff. Available at: <http://sweetgum.nybg.org/ih/>. Accessed in: 20 April 2009.
- IBGE. 2009. Instituto Brasileiro de Geografia e Estatística. Available at: <http://www.ibge.gov.br>. Accessed in: 20 April 2009.
- Kasuya T, Orihara T, Fukiharu T, Yoshimi S. 2006. A lycoperdaceous fungus, *Arachnion album* (*Agaricales*, *Arachniaceae*) newly found in Japan. *Mycoscience* 47(6): 385–387.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the fungi. 10 Edn. CAB International, Wallingford.
- Kornerup A, Wanscher JH. 1978. Methuen Handbook of Colour. 3 Edn. Eyre Methuen, London.
- Kreisel H. 1967. Taxonomisch-Pflanzengeographische Monographie der Gattung *Bovista*. J. Cramer, Lehre.
- Kreisel H. 1994. Studies in the *Calvatia* complex (*Basidiomycetes*) 2. *Feddes Repertorium* 105 (5–6): 369–376.
- Miller Jr. OK, Miller HH. 1988. *Gasteromycetes*: morphology and developmental features. Mad River Press, Eureka.
- Pegler DN, Læssøe T, Spooner BM. 1995. British puffballs, earthstars and stinkhorns. An account of the British gasteroid fungi. Royal Botanic Gardens, Kew.
- Rick J. 1961. *Basidiomycetes* Eubasidii no Rio Grande do Sul. Brasília. *Iheringia* 9: 451–480.
- Suárez VL, Wright JE. 1996. South American *Gasteromycetes* V: The genus *Morganella*. *Mycologia* 88(4): 655–661.
- Trierveiler-Pereira L, Baseia IG. 2009. A checklist of the Brazilian gasteroid fungi (*Basidiomycota*). *Mycotaxon* 108: 441–444.

Studies in lichens and lichenicolous fungi: more notes on taxa from North America 6

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Abstract — *Acarospora asperata* is placed in synonymy with *A. obnubila*. *Chiodecton subochroleucum* is placed in synonymy with *Roccellina franciscana*. *Lecanora phaeophora* is discussed. *Catillaria atomarioides*, *Echinodiscus lesdainii*, *Stigmidium ramalinae*, and *Thalloloma cinnabarinum* are reported new for North America.

Key words — *Acarosporaceae*, *Graphidaceae*, isohypocrellin, *Lecania cyrtella*, *Ramalina subleptocarpa*, *Schismatomma cupressum*

1. *Acarospora obnubila* H. Magn., Kungl. Svenska Vetensk.-Akad. Handl.
Ser. 3, 7 (4): 263 (1929).

TYPE: U.S.A. ARIZONA: ADAMANA, 1915, *Plitt* (MIN, HOLOTYPE (not located); UPS! ISOTYPE).

- = *Acarospora asperata* H. Magn., Göteborgs Kungl. Vetenskaps
Vitterhets-Samh. Handl. 6(17): 17 (1956), **syn. nov.**

TYPE: U.S.A. COLORADO: Boulder Co., WEST SIDE OF STEAMBOAT
MOUNTAIN, 3 MILES N.W. OF LYONS, on sandstone boulders, base of talus
slope, 1707 m, 7.ii.1954, W.A. Weber & S. Shuahan S1489 (COLO, HOLOTYPE;
FH! ISOTYPE).

Acarospora obnubila is distinguished by its brown squamules with a usually well-developed stipe, an algal layer interrupted by hyphal bands, and a lack of secondary metabolites (Knudsen 2008). The species was described from Arizona (Magnusson 1929), is common in California (Knudsen 2008), and has been reported in South America (Knudsen et al. 2008). *Acarospora asperata* is a well-developed specimen of *A. obnubila*, suggesting that some poorly developed specimens from southern California, at elevations below 700 meters, are at their ecological limits in the Mojave Desert and xeric microhabitats in the coastal ranges. A similar difference between specimens of *Acarospora elevata* H. Magn. (misapplied name *A. nitida* H. Magn.) can be observed. Specimens from Colorado and montane California above 1500 meters are well developed and glossy but the specimens from lower elevations from xeric microhabitats are often small and dull.

2. *Catillaria atomarioides* (Müll. Arg.) H. Kiliyas, Herzogia 5(3–4): 327 (1981).

= *Lecidea atomarioides* Müll. Arg., Flora, Jena 57: 187 (1874).

= *Catillaria lenticularis* var. *atomarioides* (Müll. Arg.) Erichsen, Flechten von Nordwestdeutschland: 153 (1957).

TYPE: FRANCE. HTE SAVOIE: “AM SALÈVE SÜDÖSTL. VON MONETIER, auf errat. block”, 1873, J. Müller Arg. (G, LECTOTYPE + ISOLECTOTYPE).

The genus *Catillaria* A. Massal. s. str is characterized by having lax, distinctly capitate paraphyses, *Catillaria*-type asci (completely amyloid tholus lacking a masse axiale), and colorless, 1-septate ascospores. Within the genus *C. atomarioides* is distinguished by its small apothecia (0.1–0.2 mm diam.), green-black throughout the true exciple, colorless hypothecium and small ascospores ($7\text{--}10 \times 2.5\text{--}3.5 \mu\text{m}$).

Catillaria chalybeia (Borrer) A. Massal. is similar but has larger apothecia (typically 0.2–0.5 mm diam.), a higher hymenium ($40\text{--}60 \mu\text{m}$ vs. $30\text{--}40 \mu\text{m}$), and a dark brown hypothecium. *Catillaria subviridis* (Nyl.) Zahlbr. is also similar but has a colorless inner exciple and larger ascospores ($10\text{--}16 \times 4.5\text{--}6 \mu\text{m}$).

Catillaria atomarioides was described from a specimen from France and has subsequently been reported from northern and central Europe, Macaronesia and South Africa (Fletcher & Coppins 2009). A full description and drawings of microscopic features are included by Kiliyas (1981). The single North American collection was made by Harold Schaefer during a field seminar at the Humboldt Field Research Institute in Steuben, Maine, led by one of us (AMF), who identified the collection.

SPECIMEN EXAMINED. – USA. MAINE: Washington Co., PETIT MANAN WILDLIFE REFUGE. HOLLINGSWORTH TRAIL, NEAR THE COAST, $44^{\circ}27'27.4''\text{N}$ $67^{\circ}56'4.4''\text{W}$, 5 m, top of granitic rocks, H. Schaefer 445, 4.viii.2009 (FH, MSC, hb. Schaefer).

3. *Echinodiscus lesdainii* (Vouaux) Etayo & Diederich, Bull. Soc. Nat. Luxemb. 100: 64 (2000).

TYPE: IRELAND. FERMANAGH (VC H33): Enniskillen, CASTLE COOLE, GURTGONELL PLANTATION, on *Lecania cyrtella*, on *Sambucus* twigs, vii. 1993, Coppins 15732 & O'Dare (E, NEOTYPE; hb. Diederich, ISONEOTYPE).

= *Phacopsis lesdainii* Vouaux [as '*lesdaini*'], Bull. Soc. Mycol. France 30: 145 (1914).

Echinodiscus lesdainii is a lichenicolous fungus known from the apothecia of *Lecania cyrtella* (Ach.) Th. Fr., *L. cyrtellina* (Nyl.) Sandst. and on the thallus of *L. erysibe* (Ach.) Mudd in France, Great Britain, Ireland, and Sweden (Etayo & Diederich 2000). The ascomata are apothecioid, 50–100(–150) µm diam., with large simple hairs, an exciple and hymenium distinguished by a violet pigment, paraphyses intermixed with hairs and 4-spored asci, 36–40 × 7–8.5 µm, with simple hyaline ascospores 5.5–8.5 × 2.5–3 µm.

Echinodiscus lesdainii was collected in the Santa Monica Mountains in southern California on *Lecania cyrtella* growing on middle-aged *Malacothamnus fasciculatus* (Torr. & A. Gray) E. Greene in mesic chaparral in upper La Jolla Valley. We report the species new for North America.

SPECIMENS EXAMINED. — U.S.A. CALIFORNIA: Ventura Co., SANTA MONICA MOUNTAINS POINT MUGU STATE PARK, UPPER LA JOLLA VALLEY, 34° 6' 37" N 119° 01' 46" W, 270 m, 13.vii.2009, Kocourková 7344 & Knudsen (hb. Kocourková).

4. *Lecanora phaeophora* (Stizenb. ex Hasse) H. Magn., Meddl. Göteb. Bot. Träg. 10: 52 (1935).

TYPE: U.S.A. CALIFORNIA: Los Angeles Co., CATALINA ISLAND, on rocks, i.1895, Hasse (ZT, HOLOTYPE! FH, ISOTYPE).

= *Biatora phaeophora* Stizenb. ex Hasse, Erythea 4:108 (1896).

= *Lecidea phaeophora* (Stizenb. ex Hasse) Hasse, Contr. U.S. Natl. Herb. 17: 44 (1913).

Biatora phaeophora (Hasse 1897 & 1913) is only known from the type collected on Catalina Island in southern California. The species has not yet been re-discovered and the type was examined during a continuing study of California's insular lichen biota. Magnusson revised the species, making an accurate description, and transferred it to *Lecanora* (Magnusson 1935) and the ascus stain is *Lecanora*-type. In the short description in the original publication, based on Stizenberger's notes, Hasse gave the size of the simple hyaline ascospores as 16 × 7 µm (Hasse 1897). The actual size of ascospores was revised by Magnusson as 9–10(–11) × 5–6 µm (Magnusson 1935) which we verified as correct. The holotype is too small to sample for thin-layer chromatography. The thallus and apothecia are UV–. The apothecium examined was K–, KC– and epihymenium was K–. In a revision of the original description, Hasse added that the ecorticate epilithic thallus, which is very thin, is K+ orange and the epihymenium is K+ violet (Hasse 1913). These details are not based on the

holotype but on a specimen of *Lecania fructigena* Zahlbr. from the type locality collected by Hasse and misidentified as *Lecidea phaeophora* (W!). Recently, the description was expanded to include information on crystals, etc. (Ryan et al. 2004). The mature apothecia are biatorine, resembling as stated by Magnusson (1935) *Lecanora polytropa* (Hoffm.) Rabenh., and are quite small in diameter (0.3–0.6 mm). This would be a good search image. It was collected on a hard rock, volcanic or a metamorphic. We hope one day it will be recollected.

5. *Roccellina franciscana* (Zahlbr. ex Herre) Follmann, in Follmann & Huneck, Philippia 4: 119 (1979) [cf. Tehler 1983]

TYPE: USA. CALIFORNIA: POINT LOBOS, SAN FRANCISCO, 1903, *Herre* 266 (FH, LECTOTYPE; ISOLECTOTYPES in RH, NY, UC, UPS, US, W).

= *Chiodecton subochroleucum* Fink, in Hedrick, Mycologia 25: 313 (1933), *syn. nov.*

TYPE: U.S.A. CALIFORNIA: "SOUTHERN CALIFORNIA", trees, *Pringle s.n.* (MICH!, HOLOTYPE; ex herb. B. Fink # 10 879).

= *Schismatomma cupressum* Herre, Bryologist 55(4): 295 (1952).

TYPE: U.S.A. CALIFORNIA: Monterey Co., MONTEREY, CYPRESS POINT, on *Cupressus macrocarpa*, 1990, *Herre* 121 (UC, LECTOTYPE; NY, UC ISOLECTOTYPES).

Fink described *Chiodecton subochroleucum* from an undated collection made by Cyrus G. Pringle from "trees in southern California." The holotype is in MICH (ex herbarium of Dr. Bruce Fink, # 10879), along with another collection made by Hasse from "near San Diego" (Fink # 11892). Hedrick (1933) and Fink (1935) give the following description: thallus thin, yellowish-white; apothecia to 1.0 mm, adnate, round to irregular, disk flat, commonly white pruinose, hypothecium brown, extending under each apothecium into a stroma of the same color; ascospores 3-septate, hyaline, $19\text{--}27 \times 5\text{--}6.5 \mu\text{m}$. Neither published description gives spot-test reactions for the thallus. Examination of the holotype revealed this description to be substantially correct, although ascospores up to $30 \times 8 \mu\text{m}$ were also observed and, in addition, the thalline margin was non-corticate and all thallus spot-test reactions were negative.

The holotype is clearly a specimen of *Roccellina franciscana* and so *C. subochroleucum* is included in the synonymy of that species. *Roccellina franciscana* is a coastal species known only from California and Mexico (Baja California) where it occurs on trees (and less often on rocks) as far north as San Francisco (Tehler 1983 & 2002).

ADDITIONAL SPECIMENS EXAMINED. – U.S.A., CALIFORNIA: San Diego Co., NEAR SAN DIEGO, *Hasse* (MICH; ex herb. B. Fink # 11892).

SPECIMENS OF *ROCCCELLINA FRANCISCANA* EXAMINED. – U.S.A. CALIFORNIA: Monterey Co., MONTEREY PENINSULA, CYPRESS POINT, 17-MILE DRIVE, BETWEEN PACIFIC GROVE AND CARMEL, on a dead sapling of *Cupressus macrocarpa*, 2.iv.1966, *W. Weber & R. Santesson* (MSC; Lichenes Exsiccati University of Colorado Museum, Boulder, Fasc. V. #

195 – as *Schismatomma cupressum*); *ibid.*, CYPRUS POINT, 18.vii.1882, *unknown collector* 656a (MSC).

6. *Stigmidium ramalinae* (Müll. Arg.) Etayo & Diederich, *Comun. Bot. Mus. Nac. Hist. Nat. Antropol.*, Montevideo 6(129): 14 (2004).

TYPE: BRAZIL. APIAHY: on *Ramalina complanata*, 1884, *Puiggari* 357 (G).

≡ *Arthopyrenia ramalinae* Müll. Arg., *Flora* 66: 319 (1883).

≡ *Pharcidia ramalinae* (Müll. Arg.) Vouaux, *Bull. Soc. Mycol. France* 28: 254 (1912).

= *Pharcidia epiramalina* Vouaux, in Pitard & Harmand, *Bull. Soc. bot. Fr.* 58(Mem. 22): 71 (1911).

TYPE: SPAIN. ILLES CANARIES: Tenerife, MONT. TAGANANA, on *Ramalina decipiens*, Dr. Pitard (herbarium location unknown).

≡ *Stigmidium epiramalina* (Vouaux) Hafellner, *Bull. Soc. linn. Provence* 44: 230 (1994).

The species is widespread in South America in Argentina, Brazil, Uruguay (Etayo & Osorio 2004), and Chile (Etayo & Sancho 2008). The black ascomata are 40–50 µm in diameter, with external periphyses. We did not observe the periphysoids, which are described as “rudimentary” (Etayo & Osorio 2004). The asci are 20–25 × 8–9 µm with 1-septate ascospores 11.5–13.5 × 2.5–3.5 µm. *Stigmidium ramalinae* was collected on *Ramalina subleptocarpha* Rundel & Bowler in the Santa Monica Mountains and is reported new for North America.

SPECIMENS EXAMINED. — U.S.A. CALIFORNIA: Ventura Co., SANTA MONICA MOUNTAINS POINT MUGU STATE PARK, UPPER LA JOLLA VALLEY, 34° 6' 37" N 119° 01' 46" W, 270 m, 13.vii.2009, *Kocourková* 7342 & *Knudsen* (hb. *Kocourková*).

7. *Thalloloma cinnabarinum* (Fée) Staiger, *Bibl. Lichenol.* 85: 432 (2002).

≡ *Graphis cinnabarina* Fée, *Essai Crypt. Écorc. Officin.*: 44 (1825).

TYPE: PERU. “HABITAT IN RAMIS JUNIORIBUS CINCHONARUM PERUVIANORUM” (G, HOLOTYPE).

≡ *Phaeographis cinnabarina* (Fée) Müll. Arg., *Mémoire. Soc.*

Phys. Hist. Nat. Genève 29(8): 27 (1887).

Thalloloma cinnabarinum, in a broad sense, constitutes a group of five species that are separated from the rest of the genus by the presence of the red epihymenial pigment isohypocrellin that reacts K⁺ green and hyaline transversely septate rather than muriform ascospores (Staiger 2002). Within this group, *T. cinnabarinum* is further distinguished by its short 5–10 septate ascospores (25–40 × 6–8 µm fide Staiger 2002), which are I⁺ blue-violet, and rounded to oval ascocarps with an open disc and conspicuous red mealy margins (Staiger 2002). Sean Beeching recently sent one of us (JCL) a collection of this taxon from Georgia, USA and it appears to be the first record of the species from North America. No other species of *Graphidaceae* presently known from North America combines the presence of isohypocrellin in the epihymenium with the other suite of characters given above.

SPECIMEN EXAMINED. – U.S.A. GEORGIA: Brantley Co., LONG BRANCH TRACT, 11.iv.2009, S.Q. Beeching s.n. (NY 1080278).

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Literature cited

- Etayo J, Diederich P. 2000. *Echinodiscus lesdainii* gen. et comb. nov., a new name for *Phacopsis lesdainii* Vouaux (lichenicolous Ascomycetes, Leotiales). Bulletin de la Société des Naturalistes Luxembourgeois 100: 63–66.
- Etayo J, Osorio HS. 2004. Algunos hongos liquenícolas de Sudamérica, especialmente del Uruguay. [Some lichenicolous fungi from South America, specially from Uruguay]. Comunicaciones Botánicas Museos Nacionales de Historia Natural y Antropología 6(129): 1–19.
- Etayo J, Sancho LG. 2008. Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). Bibliotheca Lichenologica Band 98. Germany (Berlin, Stuttgart): J. Cramer, 302 pp.
- Fink B. 1935. The Lichen Flora of the United States. Completed for Publication by Joyce Hedrick. University of Michigan Press, Ann Arbor. pp. 426.
- Fletcher A, Coppins BJ. 2009. *Catillaria* A.Massal. (1852). In: Smith CW, Aptroot A, Coppins BJ, Fletcher A, Gilbert OL, James PW, Woleseley PA (eds). The Lichens of Great Britain and Ireland, 2nd ed. British Lichen Society, London. pp. 502–519.
- Hasse HE. 1897. New species of lichens from Southern California, as determined by Dr. W. Nylander and the late Dr. Stizenberger. Bulletin of the Torrey Botanical Club 24: 445–449.
- Hasse HE. 1913. The lichen flora of southern California. Contributions from the United States National Herbarium 17: 1–132.
- Hedrick J. 1933. New genera and species of lichens from the Herbarium of Bruce Fink. I. Mycologia 25: 303–316.
- Kilius R. 1981. Revision gesteinsbewohnender Sippen der Flechtengattung *Catillaria* Massal. in Europa. Herzogia 5: 209–448.
- Knudsen K. 2008 (“2007”). *Acarospora* In: Nash TH III, Gries C, Bungartz F (eds.). Lichen Flora of the Greater Sonoran Region, Vol. 3. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 1–38.
- Magnusson AH. 1935. On saxicolous species of the genus *Lecidea* proper to North America. Meddelelser fran Göteborgs Botaniska Trädgård 10: 1–53.
- Magnusson AH. 1929. A monograph of the genus *Acarospora*. Kungl. Svenska Vetenskaps-Akademiens Handlingar, Stockholm, ser. 3, 7(4): 1–400.
- Ryan BD, Lumbsch HT, Messuti MI, Printzen C, Sliwa L, Nash TH. III 2004. *Lecanora*. In: Nash TH, III, Ryan BD, Diederich P, Gries C, Bungartz F. (eds.). Lichen Flora of the Greater Sonoran Desert Region, Vol. 2. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 177–286.

- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*. Studien in Richtung einer natürlicheren Gliederung. Bibliotheca Lichenologica, 85. J. Cramer, Berlin, Stuttgart. 526 pp.
- Tehler A. 1983. The genera *Dirina* and *Roccellina*. Opera Botanica 70: 1–86.
- Tehler A. 2002. *Roccellina*. In: Nash TH III, Ryan BD, Gries C, Bungartz F (eds.). Lichen Flora of the Greater Sonoran Desert Region, Vol. 1. Lichens Unlimited, Arizona State University, Tempe, Arizona, pp. 454–455.

Essai de découpage systématique du genre *Scutiger* (Basidiomycota): *Albatrellopsis*, *Albatrellus*, *Polyporoletus*, *Scutiger* et description de six nouveaux genres

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Résumé – Le genre *Scutiger* au sens traditionnel renferme au moins dix genres distincts: *Albatrellopsis*, *Albatrellus*, *Polyporoletus* et *Scutiger*, ici amendés, et six introduits comme nouveaux: *Laeticutis*, *Neoalbatrellus*, *Polyporopsis*, *Polypus*, *Xanthoporus*, *Xeroceps*. Une clé des genres issus du démantèlement du genre *Scutiger* s. lat. est proposée, ainsi qu'une clé des espèces signalées en Amérique du Nord et en Europe. La position systématique de ces genres est discutée d'après les résultats d'analyses moléculaires, ainsi que les caractéristiques trophiques des espèces étudiées. Divers points de taxinomie sont étudiés; en particulier la synonymie entre *Polyporopsis* (*Albatrellus*) *mexicanus* et *Polyporoletus* *sublividus* est rejetée. Une nouvelle espèce, *Polyporoletus* *bulbosus*, et onze combinaisons nouvelles sont proposées.

Abstract – *Scutiger* s. lat. is found to include at least ten distinct genera: four previously named (*Albatrellopsis*; *Albatrellus*; *Polyporoletus*; *Scutiger*, amended) and six introduced here as new (*Laeticutis*, *Neoalbatrellus*, *Polyporopsis*, *Polypus*, *Xanthoporus*, *Xeroceps*). Keys to the ten segregate genera and to the species reported from North America and Europe are provided. The systematic position of these genera based on molecular analysis and the trophic strategies of the analyzed species are also discussed. Differing taxonomic points are examined, and the synonymy between *Polyporopsis* (*Albatrellus*) *mexicanus* and *Polyporoletus* *sublividus* is rejected. One new species, *Polyporoletus* *bulbosus*, and eleven new combinations are proposed.

Keywords – *Scutigeraceae*, russuloid clade, polyporoid clade, molecular systematics, type revision

Introduction

Le genre *Scutiger* a été publié pour la première fois par Paulet en 1808. *Albatrellus*, validé par Gray en 1821, avec pour espèce-type *Boletus albidus* [= *Polyporus ovinus*], a été souvent utilisé comme synonyme et, depuis Cooke (1940), à la place de *Scutiger* dans la littérature moderne (Pouzar 1972, Gilbertson & Ryvarden, 1986, Ryvarden & Gilbertson 1993, Bernicchia 1990, Ryvarden 1991). Cependant, si l'on considère ces deux genres comme synonymes, le nom

Scutiger a priorité, comme l'ont démontré Pieri & Rivoire (2002), *Albatrellus* n'ayant jamais fait l'objet d'une proposition de conservation.

Certains auteurs ont tenté de séparer les genres *Scutiger* et *Albatrellus* sur la base de la présence ou l'absence de boucles d'anastomose (e.g. Kotlaba & Pouzar 1957). Teixeira (1993) a également utilisé ce caractère comme déterminant pour introduire *Albatrellopsis*, en remplacement de *Scutiger sensu* Kotlaba & Pouzar (1957). Cependant, Pouzar (1966) révisait sa position en affirmant qu'il existe des espèces présentant à la fois des cloisons bouclées et non bouclées. Canfield (1981) signale également la présence de boucles à la marge des basidiomes d'*A. dispansus* alors que l'on croyait l'espèce sans boucle.

Snell (1936) a créé le genre *Polyporoletus* basé sur la spore particulière, que Singer et al. (1945) ont synonymisé à *Scutiger*. Le genre *Jahnoporus*, représenté par *J. hirtus* qui partage de nombreux caractères avec les *Albatrellus*, en a été séparé par Nuss (1980) en raison de ses spores fusiformes.

L'homogénéité du genre *Scutiger* a été testé également sur la base d'études moléculaires diverses Zheng (2006) avec la grande sous-unité ribosomale et l'ITS, Miller et al. (2006) avec le gène 5.8S, l'ITS2 et la grande sous-unité ribosomale, Lutzoni et al. (2004) avec la petite sous-unité ribosomale, avec la grande sous-unité ribosomale puis avec le RPB2, Bruns et al. (1998) avec l'aide d'un petit fragment de la grande sous-unité mitochondriale. Bruns et al. (1998: 266) ont ainsi montré que *Albatrellus ellisii*, *A. skamaniaus* et *A. flettii* étaient nettement distants de *A. peckianus* et de *A. syringae*. Kim & Jung (2000) ont également montré qu'*A. syringae* appartenait à la famille des *Steccherinaceae*, distincte de celle des *Scutigeraceae*, et Lutzoni et al. (2004) ont confirmé: qu'*A. syringae* appartenait au « clade polyporoïde », très distant du « clade russuloïde » qui renferme la plupart des *Scutiger* s. lat. Plus récemment, Miller et al. (2006) ont montré que les espèces du genre *Albatrellus* étaient exclues du clade représentant le genre *Scutiger*.

Enfin, par l'analyse phylogénétique de séquences de la grande sous-unité ribosomale et de l'ITS d'un grand nombre d'espèces de *Scutiger* s. lat. Zheng (2006) a montré le polyphylétisme global de ce genre, dont quelques taxons se retrouvent exclus des *Scutigeraceae*. Néanmoins, à l'issue de son étude, l'auteur ne valide pas de nouveaux genres et maintient un genre unique *Albatrellus*, découpé en sous-genre tel que *Lignicolous* = clade I ou sections correspondant aux différents clades obtenus tels que *Confluens* = clade A, *Hymenidermiger* = clade B, *Albatrellus* = clade C, *Macrosporus* = clade E et F tous de la FIGURE 1 sauf *Cristatus* = clade E de la FIGURE 2 (Zheng (2006).

Dernièrement, Albee-Scott (2007) a mis en évidence que *Polyporoletus sublividus* (la détermination de cette espèce sera discutée plus loin) était génétiquement très proche du champignon hypogé *Mycolevis siccigleba*, et apparaîtrait génétiquement assez proche d'espèces du genre gastéroïde

Leucophleps. *Polyporoletus sublividus* serait archaïque par rapport à *M. siccigleba* selon une progression évolutive de gastéromycétisation (Albee-Scott 2007).

L'objet de cet article est d'examiner le monophylétisme du genre *Scutiger* dans son sens moderne (Pieri & Rivoire 2002). Nous avons testé la position systématique des taxons suivants, morphologiquement affines aux *Scutiger*, et en particulier: 1) les espèces à carie blanche et entièrement jaunes dès le jeune âge, classées dans le genre *Albatrellus*; 2) le genre *Polyporoletus* Snell; 3) *Albatrellus dispansus*, espèce causant une carie brune avec de très nombreux chapeaux sur une base commune; 4) l'espèce *Jahnoporus hirtus*. Pour cela, nous nous sommes appuyés sur des considérations trophiques, macroscopiques, microscopiques, chimiotaxinomiques et génétiques.

Matériels et méthodes

Notre étude a porté essentiellement sur les espèces européennes et américaines. Les spécimens ont été étudiés en macroscopie et en microscopie et en génétique. Elles ont été observées sous une loupe binoculaire Wild M3 jusqu'au grossissement 40×, puis avec un microscope Wild M20-41318 avec des objectifs fluotar grossissant jusqu'à 1125×.

Nous avons aussi utilisé un microscope Jena de Zeiss grossissant jusqu'à 1600× pour comparer les espèces du genre *Albatrellopsis* avec les espèces du nouveau genre *Neoalbatrellus*. Des microphotographies placées avant la conclusion ont été réalisées sur les holotypes des espèces mentionnées.

Les pores ont été mesurés suivant leur alignement en évitant des chevauchements, avec l'intérieur des tubes perpendiculaires: x/y où x = nombre de pores mesurées et y = nombre de spécimens.

La technique employée pour la coloration des parois des spores du groupe *Polyporoletus* est celle de Singer et al. (1945). Toutes les spores ont été mesurées de profil (apicule visible sur le côté) au grossissement 1125× en retenant les valeurs maximales estimées à 5 %; les valeurs extrêmes sont indiquées entre parenthèses. Les mesures ont été faites comme suit: x/y où x = nombre de spores mesurées et y = nombre de spécimens.

L'amyloïdie de différentes structures a été recherchée dans le Melzer (iodure de potassium 3 g, iode 1 g, chloral hydraté 44 g, eau 40 ml). Les spores ont été observées dans le bleu coton lactique (0.1 g de bleu d'aniline Merck n 1275 dans 60 g d'acide lactique et 60 ml d'eau) pour tester la cyanophilie de la paroi, le rouge Congo SDS (1 g de rouge Congo dissous dans 100 ml d'eau distillée avec 1 g de sodium dodécylsulfate) et le bleu de crésyl (quelques cristaux dans l'eau). La phloxine (en solution dans l'eau à 1%) et le KOH glycérolé à 10% (10 g de cristaux de KOH dans 80 ml d'eau distillée et 20 ml de glycérine) ont été utilisés afin de vérifier la présence du cytoplasme des hyphes à paroi épaisse de *Polyporopsis mexicanus*. Enfin nous avons utilisé le NaCl isotonique (0.9 g de NaCl dans 100 ml d'eau) afin d'observer les hyphes oléifères à contenu jaune des espèces du genre *Xanthoporus*.

Les protocoles pour l'extraction des ADN et l'amplification des gènes ITS 1 et 2 et de la grande sous-unité ribosomale (LSU) sont ceux de Stefani & Bérubé (2006).

Les séquences utilisées sont citées dans le TABLEAU 5. Les nouvelles séquences sont données entre parenthèses dans la colonne des numéros de séquences ITS. Les numéros d'accès provenant de MycoBank (<http://www.MycoBank.org>). L'abréviation des herbiers cités suit Holmgren & Holmgren (1998).

Récoltes examinées

Albatrellopsis confluens: **Canada**. Québec: Baie St-Paul, 1958 (sous *Polyporus confluens*). Dét.: R. Pomerleau (QFB 15959 L); Notre-Dame-du-Portage, 1958 (sous *Polyporus confluens*). Dét.: R. Pomerleau (QFB 15824 L); Baie St-Paul, 1960 (sous *Polyporus confluens*). Dét.: R. Pomerleau (QFB 224 L); comté de Kamouraska, Rivière-Ouelle, 1951 (sous *Polyporus confluens*). Dét.: R. Pomerleau (QFB 11185 L).

Albatrellopsis flettii: **États-Unis**. Californie: Parc national Yellowstone, lac Turbide, 1965 (sous *Polyporus flettii*). Dét.: Kent H. McKnight (NY F8366).

Albatrellus arizonicus: **États-Unis**. Arizona: « Bear Wallow, Santa Catalina Mts., Coronado Nat. Forest, Pima County », 1970. Dét.: R.L. Gilbertson (ARIZ AN009723).

Albatrellus avellaneus: **Canada**. Colombie-Britannique: Île de Vancouver, « China Beech, Jordan River », 1968 (sous *Polyporus cristatus*). Dét.: J.H. Ginns (DAOM 128999).

Albatrellus citrinus: **France**. Haute-Savoie: Passy. Dét.: Marcel Gannaz (QFB 7988).

Albatrellus ovinus: **France**. Chamonix: Haute-Savoie, 2004. Dét.: Max Pieri (QFB 7990); **Canada**. Québec: Saint-Nicolas, Lévis, 1950 (sous *Polyporus ovinus*). Dét.: René Pomerleau (QFB 10049L); Saint-Roch-des-Aulnaies, Co. L'Islet, 1945 (sous *Polyporus cristatus*). Dét.: René Pomerleau (QFB 8643L); La Pocatière, Co. Kamouraska, 1944 (sous *Polyporus cristatus*). Dét.: René Pomerleau (QFB 8642L).

Albatrellus subrubescens: **Canada**. Colombie-Britannique: Tête Jaune, 1975 (sous « *Albatrellus canadensis* »). Dét.: R.L. Gilbertson (ARIZ AN034355).

Albatrellus tianschanicus: **Kirghizistan**. « Tianghan mountains, Terskey, Hla-too, Yelandy », 1956. Dét. A.S. Bondartsev (ARIZ AN018397).

Amauroderma brasiliense: **Brésil**. « Sao Canisio do Porto Novo, Sta. Catharina, along the Uruguay River », 1928 (sous *Scutiger brasiliensis*, **co-type**). Dét.: R. Singer (FH 369).

Jahnoporus hirtus: **Canada**. Québec: Abitibi Ouest, 1978 (sous *Polyporus hirtus*). Dét.: M. Thibault (QFA 285741).

Laeticutis cristata: **France**. Pyrénées, 1997 (sous *Albatrellus cristatus*). Leg. et dét.: Serge Audet (QFB 7989); **États-Unis**. Michigan: « Haven Hill, Oakland Co. », 1981 (sous *Albatrellus cristatus*). Dét.: A.H. Smith (MICH 91664); « Haven Hill, Oakland Co. », 1981 (sous *Albatrellus cristatus*). Dét.: A.H. Smith (MICH 91407).

Laeticutis aff. *cristata*: **États-Unis**. Michigan: « Mackinaw City Hardwoods, Emmet Co. », 1961 (sous *Polyporus cristatus*). Dét.: J.P. Bennett (MICH 150A).

Leucogaster rubescens: **États-Unis**. Idaho: « Binarch Creek, Priest Lake », 1966. Dét. R. Fogel (MICH 73395).

Leucophleps spinispora: **États-Unis**. Utah: Comté de San Juan, Geyser Pass, Manti-LaSal National Forest Route 071, 1995. Dét. R. Fogel (MICH. F5136).

Mycolevis siccigleba: **États-Unis**. Idaho: Comté d'Adams, « Brundage Mountain, McCall », 1964. Dét. R. Fogel (MICH 68806).

Neoalbatrellus caeruleoporus: **États-Unis**. Caroline du Nord: « Watauga Co., Blue Ridge Mountains, Blowing Rock, Glen Mary », 1901 (sous *Polyporus holocyaneus*, **lectotype**).

Dét.: G.F. Atkinson (CUP A-010523a#); **Canada**. Québec: Québec (environ), 1999. Dét.: R. Labbé (QFB-8563); Kingsbury, comté de Richmond, 1984 (sous *Polyporus caeruleoporus*). Dét.: R. Cauchon (QFB-16558L); **États-Unis**. État de New-York: près d'Oneonta, 1963 (sous *Polyporus caeruleoporus*). Dét.: S. Smith (QFB-199L).

Polyporoletus bulbosus: **États-Unis**. Washington: « Pierce Co., Mont Rainier National Park », 1948 (sous *Polyporus canaliculatus*). Dét.: R.L. Gilbertson (MICH 68262; AHS30718).

Polyporoletus sublividus: **États-Unis**. Tennessee: « near Allardt, Fentress Co. », 1934 (**holotype**). Dét.: Singer & White (TENN 6375).

Polyporoletus sublividus s. lat.: **États-Unis**. Gt. Smoky Mt Natl. Park: Cades Cove, 1949 (sous *Polyporus canaliculatus*). Dét. Lowe (NY 3645); « Cades Cove », 1961 (sous *Albatrellus sublividus*). Dét.: L. Hesler. (DAOM 170954); Caroline du Nord: « Haywood Co., vic. Waterville, Great Smoky Mountains National Park, Baxter Creek Trail, 35° 44' 20" N, 083° 07' 01" W », 2004 (sous *Polyporoletus sublividus*). Dét.: J. Caranza (TENN 60290); Georgie: « Rabun, Highlands », 1992 (sous *Polyporoletus sublividus*). Leg.: R.H. Petersen & K.W. Hughes (51567 TENN); Caroline du Nord: « Country: Macon town », 1991 (sous *Polyporoletus sublividus*). Leg.: R.H. Petersen (050222 TENN); « Macon Co., Highlands », 1991 (sous *Polyporoletus sublividus*). Leg.: D.E. Desjardin (TENN 50031).

Polyporoletus sylvestris: **États-Unis**. Idaho: « Moscow », 1934 (sous *Polyporus sylvestris*). Dét.: E. Moise (NY 285). **Canada**. Colombie-Britannique: lac Cowichan, 1931 (sous *Albatrellus sylvestris*, **holotype**). Dét. L.O. Overholts (DAOM F1707); région de Whistler, lac Callahan, 50° 12' N 123° 11' W, 1994 (sous *Polyporoletus sublividus*). Dét. J.H. Ginns (DAOM 221078); « Grouse Mountain, North Vancouver », 49° 23' N 123° 04' W, 2001 (sous *Polyporoletus sublividus*). Dét. P. Kroeger (UBC F14386); « Slesse Creek, West Road », 1999 (sous *Polyporoletus sublividus*). Dét. P. Kroeger (UBC F14482).

Polyporopsis mexicanus (sous *Albatrellus mexicanus*, **holotype**) **Mexique**. Nabogame, Chihuahua, 1988. Dét. : J.E. Laferrière 1889 (BPI 1107534).

Polyporopsis mexicanus (sous *Albatrellus mexicanus*, **isotype**) **Mexique**. Nabogame : Chihuahua, 1988. Dét. : J.E. Laferrière (XAL 1889).

Polypus aff. *dispansus*: **Costa Rica**. San José: Dota, San Gerardo, 2000 (sous *Polyporus dispansus*). Dét.: R. E. Halling (NY; R.E. Halling 7979).

Scutiger ellisii: **États-Unis**. Idaho: « Star Creek », 1964 (sous *Polyporus ellisii*). Réc.: A.H. Smith (DAOM 95230). **États-Unis**. Wyoming: Comté d'Albany, « Upper S Brush Creek Road and Hwy 130, Snowy Range, Medicine Bow Mountains », 1998 (sous *Albatrellus ellisii*). Dét. J. States (MICH; States J. WYEF 22 Aug 1998).

Scutiger pes-caprae: **États-Unis**. Californie: « Mendocino Co., Jackson State Forest », 1971 (sous *Polyporus pes-caprae*). Dét.: H.D. Thiers. (NY; H.E.B 17052). **France**. Toutre, 1997. Dét.: Max Pieri (QFB 7993); Chalmazel, 1991. Dét.: Bernard Rivoire (QFB 7991).

Xanthoporus peckianus: **Canada**. Québec: Saint-Apolinaire, 2003. Dét.: Serge Audet (QFB 7987); Saint-Aubert, Co. L'Islet, 1948. Dét.: René Pomerleau (QFB 10066L); Saint-Maurice, 1990. Dét.: Bruno Boulet (QFB 7779); Baie-James, 2003. sur sapin. Dét.: Jean Bérubé (QFA 477852).

Xanthoporus syringae: **Canada**. Territoire du Yukon: Rivière Yukon, « Thistle Creek », 63° 06' N 139° 29' W, 1984 (sous *Albatrellus syringae*). Réc.: J.H. Ginns & W.J. Cody (DAOM 214972). **France**. Haute-Savoie: Chamonix, 2002 (sous *Scutiger syringae*). (QFB 7994).

Xerocephus skamania: États-Unis. Washington: Comté de Skamania, « Wind River Expt. Forest », 1996 (sous *Albatrellus skamanius*). Dét.: Jan Lindgren (DAOM 220694).

Résultats

LES FIGURES 1 et 2 illustrent les analyses réalisées respectivement sur les séquences ribosomales ITS1-5.8S-ITS2 et 28S de diverses récoltes rapportées au genre *Scutiger* s. lat. dans la littérature. La FIGURE 2 inclut principalement les espèces-types des genres issus du découpage de *Scutiger* s. lat. La FIGURE 1 illustre la position systématique d'un plus grand nombre d'espèces par rapport aux genres distingués sur la FIG. 2.

Dans le phylogramme présenté ici (FIG. 1), le clade regroupant *Albatrellus syringae* et *A. peckianus* (I) est exclu du clade représentant la famille des *Scutigeraceae* (A–G), qui comprend plusieurs clades correspondant au genre *Scutiger* s. lat. *Jahnoporus hirtus*, que certains auteurs ont placé dans le genre *Albatrellus*, en est très éloigné (clade H). Au sein du clade *Scutigeraceae* on constate, à la suite d'Albee-Scott (2007), que le clade A (FIG. 1) regroupant *Albatrellus confluens* et *A. flettii* inclut également l'espèce gastéroïde *Leucogaster rubescens*.

A. syringae est regroupé dans un clade indépendant, distinct du phylum regroupant les clades A à G, et, dans notre analyse, se retrouve proche de *Steccherinum-Antrodiella* (Johannesson et al. 2000). D'après la FIG. 1, *A. syringae* est très proche de *A. peckianus*, et ne se distinguent pas significativement par les ITS; toutefois nous les considérons comme espèces indépendantes, car les caractères morphologiques soutiennent la répartition géographique de ces taxons. *Albatrellus higanensis* est considéré comme identique à *A. syringae* par Y.C. Dai (comm. pers.).

Dans l'arbre de la FIGURE 1, deux récoltes identifiées sous le même nom (*Polyporoletus sublividus*) apparaissent très distantes. La récolte DAOM 221078 correspond en fait à *A. sylvestris*. La seconde est considérée comme inédite et est décrite ci-après sous le nom de *Polyporoletus bulbosus* sp. nov.; elle est rapportée au genre *Polyporoletus*, bien qu'elle semble occuper une position marginale sur ce clade, car il ne s'est pas trouvé de caractère assez déterminant pour justifier la création d'un nouveau genre. *Polyporoletus* est bien soutenu comme clade autonome (A) dans la FIGURE 2.

Dans la FIG. 1, *A. confluens* et *A. flettii* forment un clade bien soutenu (clade A), qui intègre *Leucogaster rubescens*. La similitude phylogénétique de *A. confluens* et *L. rubescens* suggère que ce dernier pourrait être une forme hypogée de *A. confluens*. La couleur rouge du péridium suggère déjà ce rapprochement. Nous avons testé l'identité d'*A. confluens* et *A. flettii* : l'analyse des ITS (FIG. 1, clade A) démontre clairement que ces deux espèces sont bien distinctes.

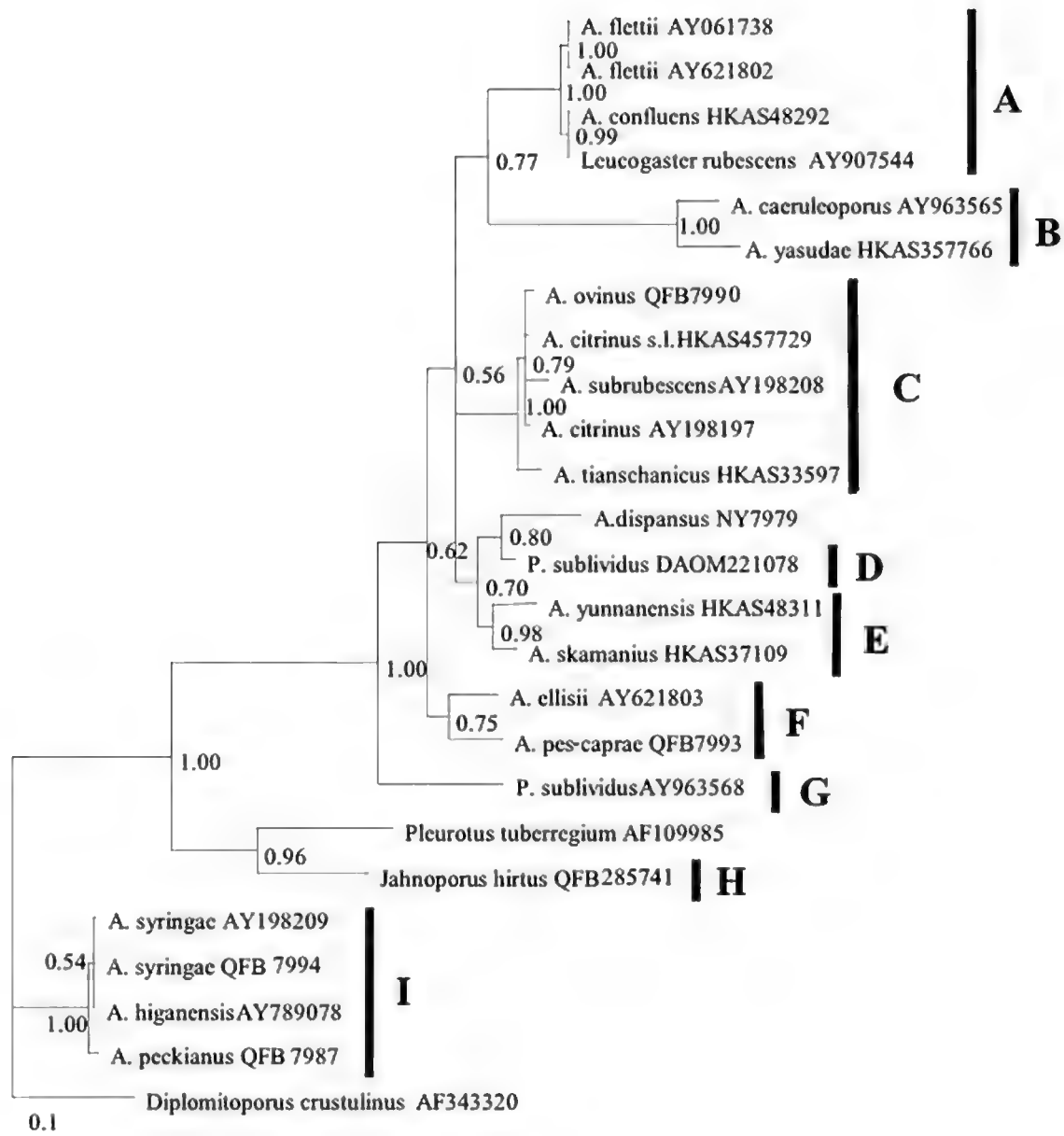


FIGURE 1: Phylogramme de strict consensus des séquences ribosomales ITS1, 5.8S et ITS2 calculé par le programme MrBayes (Huelsenbeck & Ronquist 2001; 1 000 000 générations). A: *Albatrellopsis*; B: *Neoalbatrellus*; C: *Albatrellus*; D: *Polyporoletus sylvestris* E: *Xeroceps*; F: *Scutiger*; G: *Polyporoletus bulbosus*; H: *Jahnoporus*; I: *Xanthoporus*; hors groupe: *Diplomitoporus crustulinus*.

Le clade C correspondant au genre *Albatrellus* est très bien soutenu (100%) avec l'espèce-type *A. ovinus* (FIGURE 2). Avec l'analyse des séquences ITS (FIG. 1), le genre *Albatrellus* apparaît le plus riche en espèces, avec *A. subrubescens*, *A. ovinus*, *A. citrinus* et *A. citrinus* s. lat. et peut-être *A. tianschanicus*. Pour ce dernier, l'analyse moléculaire ne fournit pas de réponse significative.

Le clade *Scutiger* s. str. (*A. pes-caprae* et *A. ellisii*) est assez peu soutenu sur la FIG. 1, mais le rapprochement est quand même fortement suggéré. Ces deux espèces sont regroupées dans un même clade par l'analyse des séquences LSU (Zheng 2006).

Albatrellus caeruleoporus et *A. yasudae* (FIG. 1) sont regroupées sur un clade monophylétique bien soutenu avec l'ITS. Les séquences LSU n'ont pas été

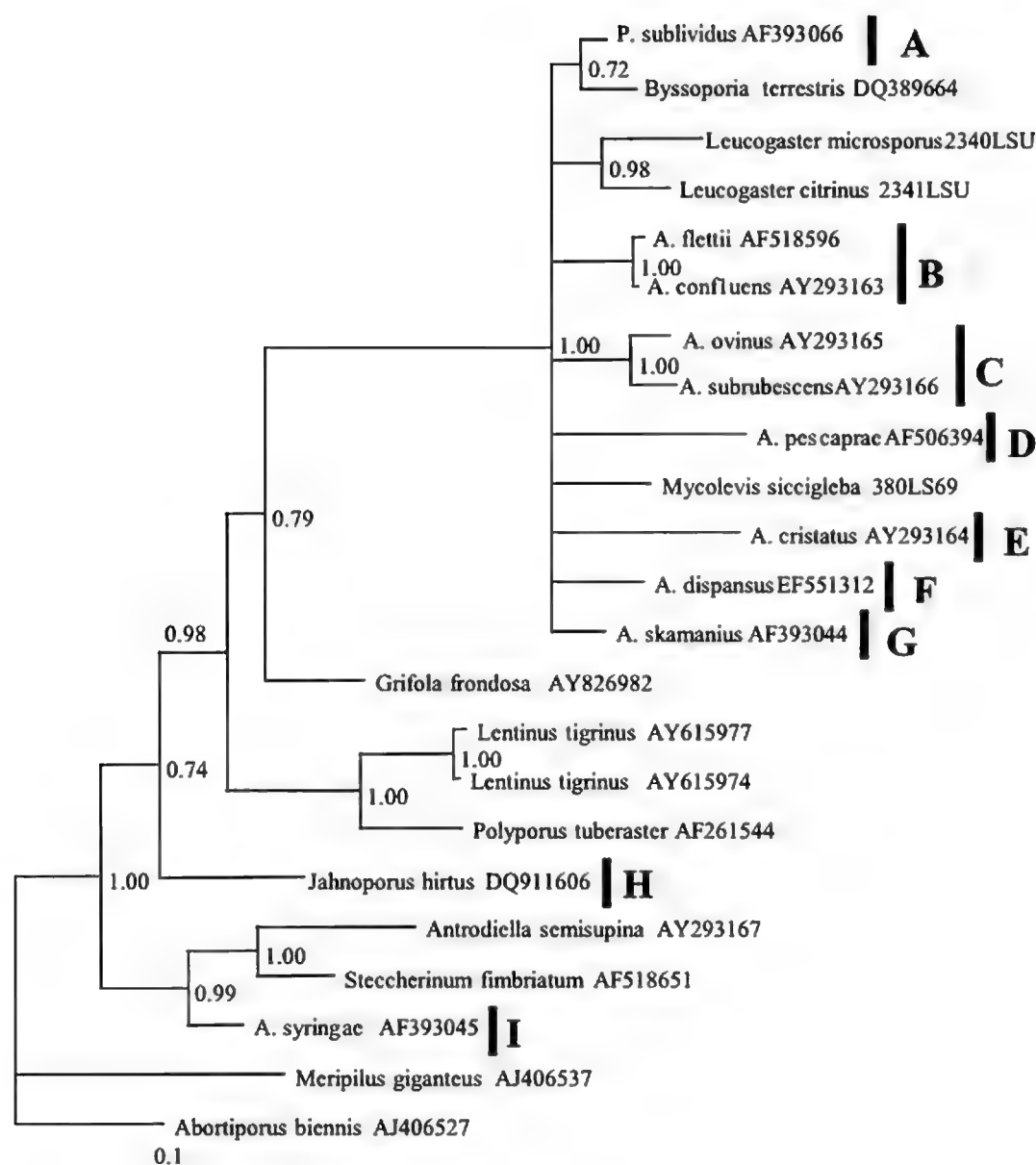


FIGURE 2: Phylogramme de strict consensus de la séquence ribosomale 28S (LSU) calculé par le programme MrBayes (Huelsenbeck & Ronquist 2001; 1 000 000 générations). A: *Polyporoletus*; B: *Albatrellopsis*; C: *Albatrellus*; D: *Scutiger*; E: *Laeticutis*; F: *Polypus*; G. *Xeroceps*; H: *Jahnoporus*; I: *Xanthoporus*; hors groupe: *Abortiporus biennis*.

obtenues pour ces espèces, mais ce regroupement est également justifié par des caractères morphologiques.

Albatrellus cristatus, seulement analysé pour la LSU (FIG. 2), semble former un clade autonome.

Le clade soutenu à 100% (FIG. 2) en F est représenté par *Albatrellus dispansus* (espèce-type du nouveau genre *Polypus*) tandis que pour la FIGURE 1 le résultat est non significatif.

Albatrellus skamanius et *A. yunnanensis* sont regroupés à 98% dans l'arbre de la FIGURE 1.

Dans la FIGURE 2, le clade contenant les groupes A à G correspond à la famille des *Scutigeraceae*, qui renferme plusieurs genres monophylétiques,

dont la plupart sont traditionnellement inclus dans le genre *Albatrellus*. *Grifola frondosa* a déjà été considéré près des *Scutiger* s. lat. (Corner 1989); selon la FIGURE 2, il en est clairement exclu.

Discussion

Chaque clade identifié par l'analyse moléculaire (FIG. 1 et 2) correspond à des groupes bien caractérisés par des caractères morphologiques distinctifs. Tous ces groupes sont considérés ici comme des genres distincts, détaillés ci-après.

Pour *Leucophleps*, il serait intéressant d'étudier la relation phylogénétique avec le genre *Polyporoletus*, car il présente parfois un péridium olive et des spores plus conformes à celles des *Polyporoletus* (endospore amyloïde et morphologie externe).

La famille dont font partie les genres *Scutiger* s. lat. et *Polyporoletus* doit être nommée *Scutigeraceae* et non *Albatrellaceae*, car Singer a validé *Scutigeraceae* en 1969 bien avant *Albatrellaceae* proposé par Nuss (1980). La famille *Scutigeraceae* Bondartsev & Singer (1941) était invalide par l'absence de diagnose latine, mais Singer (1969 : 381) l'a validée comme suit:

“*Scutigeraceae* Bondarzew & Sing., Ann. Mycol. 39 : 48. 1941 ex Sing., fam. nov.

“*Polypori stipitati uni-vel multipileati, carnosi vel carnosio-tenaces; sporis hyalinis membrana homogenea vel heterogenea sed levi inamyloidea instructis, subglobosis vel subelongatis sed raro oblongis vel cylindraceis vel fusoides; fibulis praesentibus vel absentibus; hyphis generatim hyalinis, inamyloideis; setis et metuloidibus nullis, gloecystidiis nullis; structura asterostromelloidea absente. Ectotrophice mycorrhizici vel parasitici vel saprophytice ad lignum crescunt, sed frequentius terricolae.*

“*Typus familiae : Scutiger* Paulet ex Murr.”

Albatrellopsis Teixeira, Bol. Inst. Botânica 8: 21 (1993), **emend.** Audet

TYPE: *Polyporus confluens* (Alb. & Schwein.: Fr.) Fr 1821 (= *Albatrellopsis confluens* (Alb. & Schwein.: Fr.) Teixeira)

Basidiome annuel, charnu, diversement coloré (bleu, abricot, brunâtre), circulaire ou irrégulier, à pied excentré à latéral, souvent avec plusieurs chapeaux épais superposés et pieds provenant d'une base commune, lisses à craquelés; consistance charnue; chair à une seule couche et blanche; hyménophore à pores circulaires à anguleux, 2–5/mm, blanc à crème.

Exceptionnellement hypogé de forme globuleuse et rouge avec chair alvéolée, avec nombreuses chlamydospores (*Leucogaster rubescens*).

Odeur non caractéristique; goût doux à amer (chez les vieux spécimens); entièrement orange (nécropigments) avec le temps sur les spécimens en herbier.

Réaction lilas au KOH sur chair et pores, et vinacée au FeSO_4 ou tubes, légèrement rose au binzidine sauf pour *L. rubescens*.

Système hyphal monomitique, pileipellis trichodermique à hyphes lisses ou incrustées, avec certaines extrémités hyphales à paroi épaissie et légèrement amyloïde; avec rares hyphes gléoplères présentes dans le contexte, bouclées, à paroi inamyloïde et non dextrinoïde; présence d'appendices hyphaux épineux à la base des pieds. Basides longuement claviformes. Spores ellipsoïdales à subsphéroïdales, avec large goutte huileuse, à paroi épaissie, hyalines, légèrement amyloïdes, cyanophiles, $3.8\text{--}5.2 \times 2.8\text{--}3.6 \mu\text{m}$. Chlamydospores alvéolées attestées chez *A. flettii* et *L. rubescens*. Sporée blanche. Champignon ectomycorhizien.

REMARQUES: Les *Albatrellopsis* se différencient des autres *Scutiger* s. lat. par des larges basidiomes convexes et fortement confluent avec chapeaux superposés. On note également des acanthopendices sur les hyphes à la base du pied (Pouzar 1972).

Espèces acceptées dans les *Albatrellopsis*:

Albatrellopsis confluens (Alb. & Schwein.: Fr.) Teixeira 1993

= *Leucogaster rubescens* Zeller & C.W. Dodge 1924

Albatrellopsis flettii (Morse ex Pouzar) Audet, **comb. nov.**

MYCOBANK MB 511188

≡ *Albatrellus flettii* Morse ex Pouzar, Česká Mykologie 26(4): 198 (1972).

Albatrellus Micheli ex Gray, Nat. arr. Brit. plants, I, p. 645, 1821, **emend.** Audet

LECTOTYPE (Murrill 1905 : 482): *Polyporus ovinus* (Schaeff.: Fr.) Fr. 1821

= *Boletus albidus* Pers., Synopsis methodica fungorum: 515, 1801.

= *Caloporus* Quél., Ench. fung., p.164, 1886 (nom. illeg., non *Caloporus* P. Karst. 1881)

= *Ovinus* (Lloyd) Torrend, Brotéria, Sér. Bot. 18: 121, 1920

≡ *Polyporus* sect. *Ovinus* Lloyd 1911, nom. nov. pour *Caloporus* Quél.

Basidiome annuel, coloré dans les tons jaunes, circulaire, à pied central à excentrique, solitaire et rarement concrescent, ayant des chapeaux assez épais, et charnus, lisses à squamuleux; chair à une seule couche et blanche; hyménophore poré, à pores circulaires à anguleux, 3–5/mm, blanc à jaune pâle au froissement.

Odeur non caractéristique; goût doux, acide ou amer; présence de parties orange (nécropigments) sur la grande majorité des spécimens en herbier avec le temps (tubes et bases de pieds).

Réaction jaune au KOH et gris sombre au FeSO_4 sur la chair. Rouge-brunâtre pâle au H_2SO_4 . Réaction orange avec teinte rouge au benzidine.

Système hyphal monomitique, à revêtement du chapeau trichodermique, à hyphes lisses, avec larges hyphes gléoplères présentes dans le contexte et

parfois dans l'hyménophore, non bouclées, à paroi amyloïde ou inamyloïde et non dextrinoïde, à paroi mince à épaisse dans les pieds. Éléments cystidioïdes (poils au sens de Pouzar 1972) amyloïdes et à paroi épaisse souvent à la base des pieds ou sinon sur les chapeaux. Basides longuement claviformes. Spores ellipsoïdales à subsphéroïdales, avec large goutte huileuse, à paroi mince, hyalines, amyloïdes ou inamyloïdes, cyanophiles, $3.0-5.7 \times 2.5-4.2 \mu\text{m}$. Sporée blanche. Champignon ectomycorhizien.

Espèces acceptées dans les *Albatrellus*:

Albatrellus avellaneus Pouzar 1972

Albatrellus citrinus Ryman 2003 (Ryman et al. 2003)

Albatrellus ovinus (Schaeff. : Fr.) Murrill 1903

Albatrellus subrubescens (Murrill) Pouzar 1972

Albatrellus piceiphilus B.K. Cui & Y.C. Dai (Cui et al. 2008).

Espèces dont la position est à confirmer:

Albatrellus arizonicus Gilb. 1991

Albatrellus cantharellus (Lloyd) Pouzar 1972

Albatrellus tianschanicus (Bondartsev) Pouzar 1966

Espèces de position systématique non résolue:

Albatrellus pilosus (Petch) Ryvarden (Ryvarden & Johansen 1980)

Espèce ayant des basidiospores cylindriques. Ce type de spores n'a jamais été observé chez d'autres espèces d'*Albatrellus* s. str.

REMARQUES: Les *Albatrellus* se différencient des autres *Scutiger* s. lat. par des basidiomes blancs puis jaunissant avec l'âge ou au froissement, des petits pores, un système hyphique sans boucles et des petites spores.

A. tianschanicus (FIG. 1) se différencie des autres *Albatrellus* par des basidiomes élancés à chapeaux minces, fragiles et déprimés, des spores ovoïdes et légèrement amyloïdes. Une analyse de la grande sous-unité ribosomale incluant cette espèce et idéalement son espèce voisine *A. cantharellus* serait souhaitable afin de déterminer si elles appartiennent à un genre indépendant.

***Laeticutis* Audet, gen. nov.**

MYCOBANK MB 511175

Basidiosporae plerumque longiores quam $5,5 \mu\text{m}$, modice amyloideae ac haud amyloideae; hyphae generativae normaliter haud fibulatae ac fibulatae.

TYPUS GENERIS: *Polyporus cristatus* (Schaeff.: Fr.) Fr., Syst. Mycol. 1: 356 (1821).

ÉTYMOLOGIE: belle surface du chapeau

Basidiome annuel; chapeau variablement coloré (vert olive pâle à brun olive parfois jaune au centre) convexe ou déprimé, feutré, circulaire ou irrégulier, à

pied central à excentré, souvent concrescent, chapeaux épais ou plus minces, et charnus, lisses à craquelés, chair à une seule couche et blanche; hyménophore poré, blanc à olivâtre.

Odeur non caractéristique; goût doux; parties oranges (nécropigments) sur certains spécimens en herbier avec le temps.

Réaction rouge violet vif au H_2SO_4 sur la chair, rouge cerise sur la chair et l'hyménophore au KOH.

Revêtement du chapeau trichodermique, à hyphes lisses ou parfois incrustées. Système hyphal monomitique, à larges hyphes gléoplères présentes dans le contexte et parfois dans l'hyménophore, non ou rarement bouclées, à paroi amyloïde ou inamyloïde et non dextrinoïde, à paroi mince à épaisse. Présence d'extrémités hyphales vésiculeuses. Hyphes fortement amyloïdes dans le pied. Basides longuement claviformes. Spores ellipsoïdales à subsphéroïdales, avec large goutte huileuse, à paroi mince à épaissie, hyalines, non à légèrement amyloïdes, cyanophiles, $4.8-7.2 \times 4.0-5.4 \mu m$. Sporée blanche. Champignon ectomycorhizien.

Espèce acceptée dans *Laeticutis*:

Laeticutis cristata (Schaeff.: Fr.) Audet, **comb. nov.**

MYCOBANK MB511176

≡ *Boletus cristatus* Schaeff.: Fr., Fung. Bavar. Palat. 4: 93 (1774)

REMARQUES: *Laeticutis* se différencie des autres *Scutiger* s. lat.. par des basidiomes fissurés à chapeau brun à olive, par des hyphes à extrémités en partie vésiculeuses, et par des spores en majorité plus longues que $5.5 \mu m$.

Neoalbatrellus Audet, **gen. nov.**

MYCOBANK MB511206

Cutis pilei e cellulis pyriformibus modo palisadiformi composita; hyphae generativae haud fibulatae; basidiosporae ovoideae vel breviter ellipsoideae, haud amyloideae.

TYPUS GENERIS: *Polyporus caeruleoporus* Peck, Bulletin of the Buffalo Society of natural Sciences 1: 60 (1873).

ÉTYMOLOGIE: nouveau genre proche d'*Albatrellus*

Basidiome annuel, bleu grisâtre ou noir avec teinte de bleu, ou noir pâissant en teintes de brun, circulaire, à pied central à excentré, parfois concrescent, chapeaux assez minces, et charnus, lisses à squamuleux, laqué ou non; chair à une seule couche et blanche; hyménophore poré, bleu ou pâle.

Odeur agréable; goût indéterminé; presque entièrement orange avec le temps (nécropigments) sur la grande majorité des spécimens en herbier.

Réaction orange sur le basidiome au KOH ou rouge foncé puis brun rougeâtre sur le chapeau ou le pied, ou brun violet sur le pied; hyménophore de certains spécimens au KOH brun violet ou couleur argile; chair jaune pâle au $FeSO_4$ ou rouge pâle au KOH.

Revêtement du chapeau hyménodermique. Système hyphal monomitique, à hyphes lisses, avec larges hyphes présentes dans le contexte et parfois dans l'hyménophore, non bouclées ou très rarement bouclées (base du pied), à paroi inamyloïde et non dextrinoïde. Basides longuement claviformes à longs stérigmates. Spores largement ellipsoïdes à subglobuleuses, avec large goutte huileuse, à paroi épaissie, hyalines, inamyloïdes, cyanophiles et non dextrinoïdes, $4.0-5.2 \times 3.3-4.4 \mu\text{m}$. Sporée blanche. Champignon saprophyte à carie blanche et peut-être ectomycorhizien.

Espèces acceptées dans les *Neoalbatrellus*:

***Neoalbatrellus caeruleoporus* (Peck) Audet, comb. nov.**

MYCOBANK MB511207

= *Polyporus caeruleoporus* Peck, Bulletin of the Buffalo

Society of natural Sciences 1: 60 (1873).

= (verifié) *Polyporus holocyaneus* G. F. Atk. 1902

***Neoalbatrellus yasudae* (Lloyd) Audet, comb. nov.**

MYCOBANK MB 511813

= *Polyporus yasudae* Lloyd ('yasudai'), Mycol. Writ. 4 (Letter 44) 10 (1913).

REMARQUES: Ce nouveau genre est justifié par le fait que *N. caeruleoporus* produit de la laccase extracellulaire dans ses basidiomes et cause donc une carie blanche (Marr et al., 1986). Pour *N. yasudae* ce caractère reste à confirmer. Le revêtement hyméniforme avec cellules pyriformes le distingue encore des autres genres cités.

***Polypus* Audet, gen. nov.**

MYCOBANK MB 511173

A ceteris Scutigeris s.l. differt stipitibus plurimis (10–20) e basi communi, pileis intente luteis vel succineis ac hyphis contexti irregulariter inflatis (aliquot tumores usque $40 \mu\text{m}$ crassi); brunneam cariem efficit.

TYPUS GENERIS: *Polyporus dispansus* Lloyd, Mycol. Writ. 3 (Syn. Stip. Polyporoids): 192 (1912)

ÉTYMOLOGIE: à plusieurs pieds

Basidiome annuel, chapeau jaune foncé, circulaire ou irrégulier, à pied central, avec une base commune portant plusieurs chapeaux minces, et charnus, finement tomenteuse ou crevassée; chair à une seule couche et blanc pâle devenant rouge cerise au KOH; hyménophore poré anguleux, blanc.

Odeur non caractéristique; goût amer; tubes cinabre en herbier avec le temps.

Revêtement du chapeau trichodermique. Système hyphal monomitique, à hyphes lisses avec expansions vésiculeuses irrégulières et constriction dans le contexte, avec hyphes gléoplères présentes, non bouclées ou bouclées à la marge, à paroi inamyloïde et non dextrinoïde, à paroi mince. Basides longuement

claviformes. Spores largement ellipsoïdes à subglobuleuses, à paroi mince, hyalines, inamyloïdes, cyanophiles et non dextrinoïdes, $4.0-4.5 \times 3.1-3.6 \mu\text{m}$. Sporée probablement blanche. Champignon saprophyte à carie brune et reporté ectomycorhizien.

Espèce acceptée dans *Polypus*:

Polypus dispansus (Lloyd) Audet, **comb. nov.**

MYCOBANK MB 511174

= *Polyporus dispansus* Lloyd, Mycol. Writ. 3 (Syn. Stip. Polyporoids): 192 (1912)

REMARQUES: *Polypus* se différencie des autres *Scutiger* s. lat. par ses nombreux pieds et chapeaux (10–20) sur une base commune, par sa carie brune et par des hyphes à expansions vésiculeuses irrégulières et constriction dans le contexte.

Polyporoletus Snell, Mycologia, 28: 467 (1936), **emend.** Audet (FIG. 3, 5)

TYPE: *Polyporoletus sublividus* Snell, Mycologia 28: 467 (1936)

Basidiome annuel, coloré (jaune, olive), circulaire ou irrégulier, à pied central à latéral, parfois cespiteux portant un chapeau épais, et charnu, méchuleux; croissance charnue; chair à une seule couche et blanche à verte ou sombre bleuâtre foncé à la coupe; hyménophore poré, gris à gris bleuâtre ou gris olivâtre, à pores arrondis à anguleux 0.7–3mm/pore.

Odeur non caractéristique; goût doux, présence constante de parties orange (nécropigments) sur la grande majorité des spécimens en herbier avec le temps.

Revêtement du chapeau trichodermique. Système hyphal monomitique, à hyphes parfois incrustées ou lisses, avec larges hyphes gléoplères présentes dans le contexte et parfois dans l'hyménophore, bouclées ou non, à paroi amyloïde ou inamyloïde et non dextrinoïde, à paroi mince. Éléments cystidioïdes (poils au sens de Pouzar 1972) amyloïdes et à paroi épaisse sur les pieds ou sur les chapeaux. Basides cylindriques-clavées à très longs stérigmates, $6-9.7 \times 1-2.2 \mu\text{m}$. Spores ellipsoïdales à subsphéroïdales, parfois incrustées, avec large goutte huileuse, à paroi double séparée par des piliers interpariétaux ou sinon lacunaire, à surface verruqueuse, verdâtres, parfois amyloïdes (endospore) ou inamyloïdes, cyanophiles et non dextrinoïdes, $9.0-13.8 \times 7.2-12.6 \mu\text{m}$. Sporée olive. Champignon ectomycorhizien.

Polyporoletus bulbosus Audet, **sp. nov.**

MYCOBANK MB 511186

A typo Polyporoleti sylvestris stipite bulboso et basidiomate solitario differt.

HOLOTYPE: États-Unis. Washington: «Pierce Co., Mont Rainier National Park», 1948 (sous *Polyporus canaliculatus*). Dét.: R.L. Gilbertson (MICH 68262, coll. A.H. Smith n°30718).

ÉTYMOLOGIE: bulbeux, fait référence au pied

(EXSICCATA): Basidiome solitaire ou d'apparence complètement soudé, à chair blanche tournant au vert lorsque coupée (frais, note de la récolte) et amyloïde au Melzer; chapeau jaune olivâtre 3.1–6.9 cm de diam. et amyloïde au Melzer, convexe à déprimé, avec méchules dressées et dispersées; à marge enroulée; pores anguleux, 1–2 pores/mm; olive modéré sur le pied, à pied latéral à central mais toujours courbé et bulbeux, 3–6.8 cm × 2.2–3.3 cm; tubes décurrents de 0.5 mm à 1 mm d'épaisseur environ, tubes et pores gris.

MICROSCOPIE: Système hyphal monomitique, à hyphes du pileipellis parfois ramifiées ou ampullacées, à paroi mince, épaisse à très épaisse 3.6–16.2 µm de diam., certaines hyphes à élargissements variables ou d'autres à contenu vert et granuleux, septées-simples ou bouclées, présence de plusieurs terminaisons hyphales amyloïdes, parfois courbées, à paroi épaisse à très épaisse surtout à l'apex, hyphes gléoplères occasionnelles verdâtres; hyphes du contexte 5.4–16.2 µm de diam., souvent ramifiées et un peu ampullacées, septées-simples ou bouclées, à paroi mince, parfois avec plages amyloïdes ou avec paroi légèrement amyloïde; hyphes gléoplères parfois présentes, jusqu'à 9 µm de diam.; hyphes de l'hyménophore 1.8–5.4 µm de diam., à paroi mince, bouclées, flexueuses et souvent ramifiées, avec extrémités hyphales en pointe.

Basides à 4 stérigmates, avec boucle basale, 49 × 22 µm.

Cystides ou autres éléments stériles absents.

Basidiospores ovoïdes à largement ellipsoïdes, à apicules distincts, 9–13.3 (–13.8) × (7.2–)7.8–10.8 µm à endospore parfois faiblement amyloïde; lisses ou ornementées, à paroi double séparée par des piliers.

COMMENTAIRES: L'espèce ici décrite, initialement identifiée *A. sylvestris*, est génétiquement très différente de l'autre récolte citée ici sous ce nom *Polyporoletus sylvestris* (DAOM221078, voir FIG. 1); malgré de notables différences macroscopiques, la microscopie des deux récoltes est semblable. *Albatrellus sylvestris* est une espèce de l'ouest américain, cespiteuse et avec pied en fuseau avec base rétrécie.

Bien que Gilbertson & Ryvarden (1986) mettent en synonymie *P. sublividus* et *P. sylvestris*, nous nous rangeons à l'opinion de Pouzar (1972) selon laquelle ces deux taxons sont différents (TABLEAU 1). Nous ajoutons certaines différences non observées par ce dernier auteur.

Polyporoletus sublividus est ici considéré dans un sens collectif regroupant au moins trois sinon quatre espèces. La récolte-type de *P. sublividus* est très différente des autres récoltes identifiées sous ce nom dans l'est de l'Amérique du Nord: le basidiome est fortement olive avec un chapeau à marge régulière, un hyménophore réduit et un pied presque latéral. L'espèce la plus commune de ce groupe a un plus gros chapeau jaune avec une marge irrégulière et un pied central. Une autre encore, représentée par la récolte n° 170954 (DAOM)

TABLEAU 1: Comparaison entre *Polyporoletus sublividus* et *P. sylvestris*

	<i>P. sublividus</i> s. lat.	<i>P. sylvestris</i>
ORNEMENTS DU CHAPEAU	grosses squamules	moins grosses squamules
ASPECT BASIDIOME	solitaire ou avec basidiome avorté	généralement cespiteux
CHAPEAU, SEC	olive à jaune ocre ou parfois gris par endroits dû aux tomentum	olive à jaune olivâtre accentué
CHAPEAU, FRAIS	sombre bleuâtre foncé tachant le papier bleuâtre foncé ⁴	chamois, froissant vert ³
CONTEXTE, EN HERBIER	variablement blanc et rouge orangé à distinctement cinabre	olive pâle, jaune olivâtre puis gris, à un peu orangé
CONTEXTE, FRAIS	blanc devenant lentement bleuâtre sombre puis sombre ⁴	blanc froissant vert ³
TUBES, SEC	jusqu'à 3.5 mm de long avec teintes d'olive	jusqu'à 0.7 mm de long
		de 0.7 à 1.5 mm de long ²
		avec teintes d'olive chez les très jeunes exemplaires seulement de 1 à 5 mm de long (L.O.O.) ¹
TUBES, FRAIS	de 8 à 12 mm de long ¹ grisâtre bleu ⁵	pores: gris terne ou gris lilas ³
TUBES SUR LE PIED	avortés jusqu'à près de l'extrême base	décurrents sur une partie du pied
ARÊTES DES PORES, EN HERBIER	grossièrement fimbriées	légèrement fimbriées
PIED	cylindrique et élargi ou plus étroit à la base	distinctement en fuseau avec base rétrécie
PIED, EN HERBIER	jaune olivâtre sans trace de nécropigments en surface	olivâtre avec traces de nécropigments cinabre en surface
PAROI SPORALE	lacunes ou piliers interpariétaux	piliers interpariétaux
SPORES	(10.2–)10.8–13.8 × (9.0–)9.6–12(–12.6) µm où 25/4	(9.6–)10.2–13.2(–13.8) × 8.4–9.9 µm où 16/2

¹ Overholts (1953) ² Pouzar (1972) ³ Ginns (1997) ⁴ notes coll. TENN 47432 ⁵ note coll. indét.

a un chapeau violacé foncé avec des mèches jaune soufre et un pied excentré. Nos observations sur ce complexe d'espèces corroborent en bonne partie celles d'Albee-Scott (2005).

Espèces acceptées dans les *Polyporoletus*:

Polyporoletus bulbosus

Polyporoletus sublividus Snell 1936

Polyporoletus sylvestris (Overh. ex Pouzar) Audet, **comb. nov.**

MYCOBANK MB 511187

≡ *Albatrellus sylvestris* Overh. ex Pouzar, Česká Mykologie 26(4): 199 (1972).

REMARQUE: *Polyporoletus* est un genre à part basé avant tout sur la spore à paroi double, dont les couches sont séparées par des piliers interpariétaux ou lacunaires. L'endospore est parfois amyloïde, rappelant celle de *Leucophleps spinispora*. Ce type de spores nous fait aussi penser à celles des *Amauroderma* (Coelho et al. 2007). Les données génétiques nous portent à croire que *Polyporoletus* est un genre autonome (voir FIGURE 2), ce qui contredit l'opinion de Singer et al. (1945) et Hawksworth et al. (1995), qui classent ces espèces dans le genre *Scutiger* s. lat. par le fait que ses spores immatures sont semblables à celles des *Scutiger* (Singer et al. 1945). De ce fait, ils n'ont pas accordé d'importance à la double paroi des spores. Les grands stérigmates et l'hyménophore normalement gris foncé sont autant de caractères que l'on ne retrouve pas chez les *Scutiger* s. lat.

***Polyporopsis* Audet, gen. nov.**

MYCOBANK MB511613

A plerisque Amaurodermatibus differt constitutione haud coriacea usque ad duram, pileo haud obscuro nec zonato, corticis vel crustae absentia, mediocriter brevi et latiore stipite, haud valliformi pileipelle, longe clavatis basidiis et ellipsoideis sporis.

ÉTYMOLOGIE: qui a une ressemblance avec *Polyporus*.

TYPUS GENERIS: *Albatrellus mexicanus* Laferr. & Gilb., Mycotaxon 37: 184 (1990).

Basidiome annuel, circulaire, simple ou confluent; à pied central à excentré, 3–5 cm de long, 10–20 mm d'épaisseur, portant des chapeaux épais, convexes et charnus, 5–10 cm de diamètre, à revêtement papyracé, tan (frais) à brun pâle en séchant, glabre; chair à une seule couche et blanche; hyménophore à pores anguleux, 1–2/mm, blanc et séchant brun clair.

Revêtement du chapeau indéterminé. Système hyphal dimitique, à hyphes lisses, hyphes génératrices du contexte et de la trame à paroi mince, 4–10 µm de diamètre, hyphes squelettiques arboriformes, à paroi mince, et très épaisse surtout dans l'hyménophore, parfois brunâtres, avec hyphes gléoplères présentes dans le contexte et l'hyménophore, avec boucles rares, 5–11 µm en diamètre, à paroi inamyloïde et non dextrinoïde. Basides claviformes, 36–46 × 9–11 µm. Spores ellipsoïdales à largement ellipsoïdales, avec large goutte huileuse, à double paroi d'apparence ponctuée, hyalines ou jaunâtres, inamyloïdes, non dextrinoïdes, (7.0–)8.0–10.0(–10.4) × (5.0–)6.0–7.5(–8.0) µm. Sporée probablement jaune.

Espèce acceptée dans les *Polyporopsis*:

***Polyporopsis mexicanus* (Laferr. & Gilb.) Audet, comb. nov.** (FIGS. 4, 6)

MYCOBANK MB511812

= *Albatrellus mexicanus* Laferr. & Gilb., Mycotaxon 37: 184 (1990).

REMARQUES: Laferriere & Gilbertson (1990) ont classé cette espèce dans le genre *Albatrellus* sans avoir remarqué la double paroi des spores ni tenu compte du

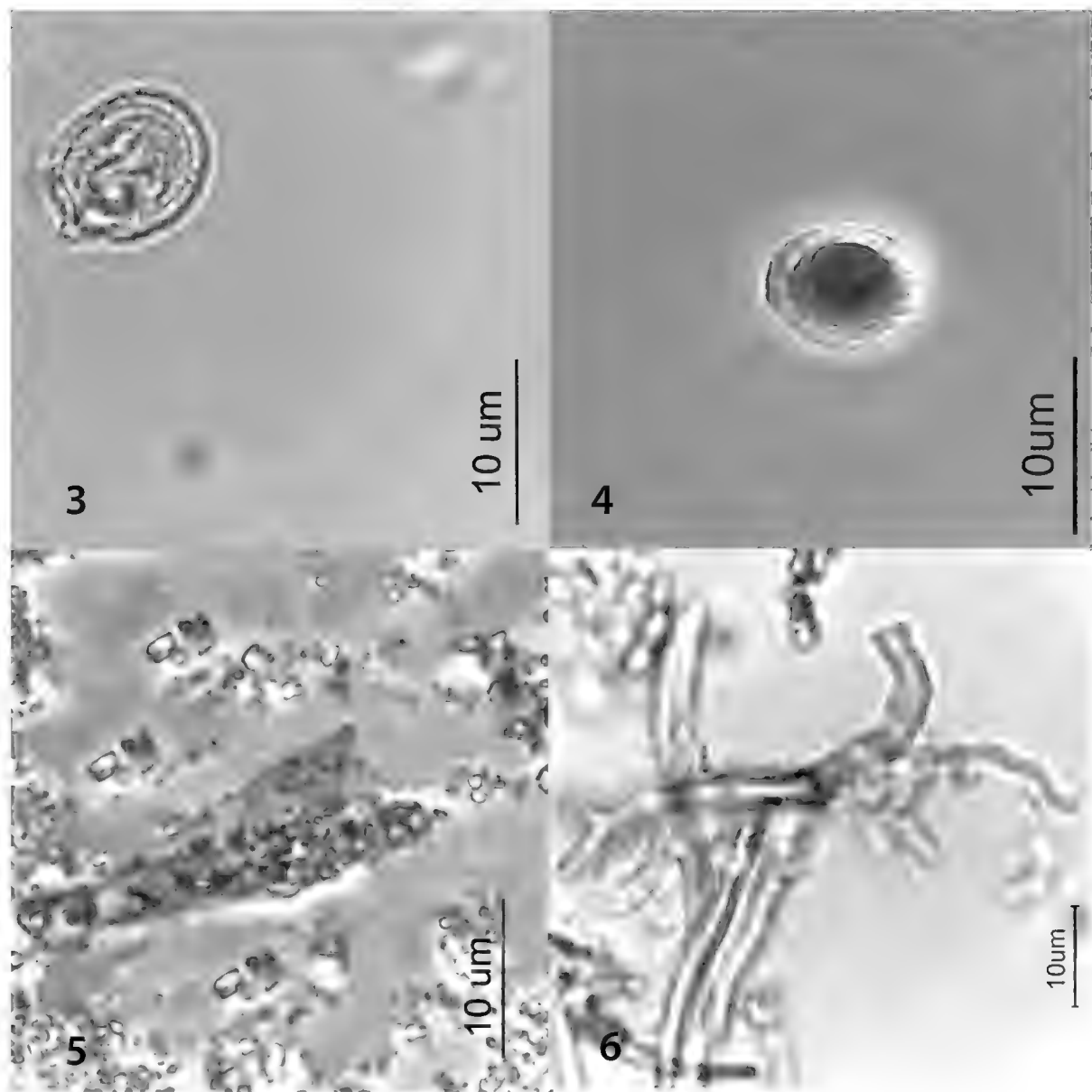


FIGURE 3. Spore de *Polyporoletus sublividus*. FIGURE 4. Spore de *Polyporopsis mexicanus*. FIGURE 5. Hyphes hyménophorales de *Polyporoletus sublividus*. FIGURE 6. Hyphes hyménophorales de *Polyporopsis mexicanus*.

système hyphal; Zheng & Liu (2006) l'ont synonymisée à *Polyporoletus sublividus* sans considérer le système hyphal dimitique ni d'autres éléments absents du genre *Polyporoletus*. Par divers caractères surtout microscopiques, notre espèce se rapproche du genre *Amauroderma* mais certains caractères microscopiques ne correspondent pas à ce genre et la morphologie du basidiome en est très éloignée selon Ryvarden (comm. pers.). Une recherche extensive dans la littérature a été faite afin de trouver un genre adéquat, sans résultat.

Les différences observées entre *P. mexicanus* et *P. sublividus* s. lat. sont consignées dans le TABLEAU 2.

En résumé *P. sublividus* est une espèce olive avec pores gris et tubes avortés sur le pied, avec un revêtement trichodermique, avec des hyphes génératrices

TABEAU 2: Comparaison entre *Polyporoletus sublividus* et *Polyporopsis mexicanus* (exsiccata)

<i>Polyporoletus sublividus</i> (holotype)	<i>Polyporopsis mexicanus</i> (holotype)	<i>Polyporoletus sublividus</i> s. lat. coll (50031; 50222; 51567)	<i>Polyporopsis mexicanus</i> (isotype)
basidiome à prédominance olive	basidiome à prédominance brun jaune	basidiome à prédominance jaune	basidiome à prédominance brun jaune
pores arrondis à allongés, déformés, gris	pores anguleux, brun résineux	pores arrondis à allongés, déformés, gris	pores anguleux, brun résineux
tubes décurrents, et avortés jusqu'à près de l'extrême base du pied	tubes un peu décurrents	tubes décurrents, et avortés jusqu'à près de l'extrême base du pied	tubes un peu décurrents
revêtement du chapeau de type trichodermique ¹	revêtement du chapeau de type indéterminé		
hyphes fortement incrustées	hyphes non incrustées	hyphes fortement incrustées	hyphes non incrustées
hyphes génératrices seulement	hyphes génératrices, squelettiques arboriformes (dimitique)	hyphes génératrices seulement	hyphes génératrices, squelettiques arboriformes, jaunes (dimitique)
certaines extrémités hyphales du chapeau et du pied amyloïdes	hyphes non amyloïdes	certaines extrémités hyphales du chapeau et du pied amyloïdes	hyphes non amyloïdes
spores olivâtres (sporée olive)	spores hyalines à jaunâtres probablement jaunes en dépôt	spores olivâtres (sporée olive)	spores hyalines à jaunâtres probablement jaunes en dépôt
spores largement ellipsoïdes à subglobuleuses, légèrement amyloïdes et verruqueuses	spores ellipsoïdes à largement ellipsoïdes, non amyloïdes et d'apparence ponctuées	spores largement ellipsoïdes à subglobuleuses, légèrement amyloïdes	spores ellipsoïdes à largement ellipsoïdes, non amyloïdes
spores: 10.2–12.7 × (9–)10.2–12 µm où 6/1	spores: 6.5–8.2 × 5.0–7.2 µm où 4/1 D'après Zheng (2006): (7–)8–10(–10.4) × (5–)6.–7.5(–8) µm, [n = 100, Q = (1.03–)1.21–1.46(–1.64); Q = 1.34±0.09]	spores: 10.8–13.8 × 9.6–12(–12.6) µm où 19/3	spores: 6.6–9.6 × 6.6–8.7 µm où 6/1

¹. Elrod & Blanchard (1939)

et des spores plus grandes, tandis que *Polyporopsis mexicanus* est une espèce brun jaune avec pores brun résineux sur le sec et tubes non avortés sur le pied, avec un revêtement indéterminé, avec un système hyphal dimitique et avec des spores plus petites.

Scutiger Paulet, Prosp. Tr. Champ.: 49 (1808), **emend.** Audet

LECTOTYPE (Murrill 1905): *Scutiger tuberosus* Paulet, iconographie du Tr. champ., pl. 31 FIG. 1–3 (1809)

= *Polyporus pes-caprae* Pers. : Fr., Traité champ. comest., p. 241, t. 3, 1818. Voir Pieri & Rivoire (2002) ¹.

Basidiome annuel, diversement coloré (jaune, brun), en éventail, à pied excentré à latéral, parfois con crescent, écailleux; chair à une seule couche et de couleur claire sur le frais; consistance charnue; hyménophore à pores anguleux et larges: (0.3–)1(–2) par millimètre, et pâles ou exceptionnellement en partie hydnoïde (*S. pes-caprae*).

Odeur non caractéristique; goût doux; (nécropigments) plus ou moins orange sur une partie des spécimens en herbier avec le temps.

Système hyphal monomitique, à revêtement du chapeau trichodermique, à hyphes lisses, avec larges hyphes gléoplères présentes dans le contexte et parfois dans l’hyménophore, bouclées ou non, à paroi amyloïde ou inamyloïde et non dextrinoïde, à paroi mince à épaisse. Basides longuement claviformes. Spores ellipsoïdales à lacrymoïdes, avec large goutte huileuse, à paroi mince, hyaline, inamyloïde, cyanophile et non dextrinoïde, 8.0–12.8 × 5.6–8.8 µm. Chlamydospores alvéolées en hexagones attestées chez *S. ellisii*. Sporée blanche. Champignon ectomycorhizien.

Espèces acceptées dans les *Scutiger* s. str.:

Scutiger ellisii (Berk.) Murrill 1903

Scutiger pes-caprae (Pers.: Fr.) Bondartsev & Singer 1941

REMARQUES: Les vrais *Scutiger* se différencient facilement des autres genres décrits ici par des basidiomes flabelliformes et écailleux avec un pied latéral, et par les grandes spores ellipsoïdales à lacrymoïdes. Selon Pegler (1967) les *Scutiger* produiraient des sclérotés hypogés (« underground sclerotium »), contrairement aux *Albatrellus* s. lat. Cette affirmation pourrait cependant n’avoir été inspirée que par l’épithète *tuberosus* donnée par Paulet (1809): Ryvarden (1991) affirme que *P. pes-caprae* n’a jamais été trouvé avec un sclérote.

Contrairement à Ryvarden (1991), nous adoptons le genre *Scutiger* lectotypifié par *Scutiger tuberosus*, synonyme de *S. pes-caprae*. En plus des arguments de Pieri & Rivoire (2002), il est clair pour Paulet (Traité champ., 1808: 122–123) que le nom Savatelle-truffe (*Scutiger tuberosus*) se réfère à plusieurs caractères morphologiques et organoleptiques rappelant la truffe et non à un sclérote. Par ailleurs «savatelle» (petite savate) fait référence à un chapeau en forme de semelle, ce qui exclut *Polyporus tuberaster*, à pied central.

¹ Les informations concernant les dates exactes de publication de Paulet ont été fournies par Jacques Melot, expert en nomenclature (comm. pers.).

***Xanthoporus* Audet, gen. nov.**

MYCOBANK MB511092

Scutigeros s.l. revocat, sed ab eis differt basidiomatibus primum luteis dein aetate frictuque fusciscentibus in pileis, praesentia in carne hypharum oleiferarum luteis interioris, basidiis nexis candelabrorum instar ac sporis haud cyanophilis. Cariem albam in ligno angiospermarum (raro coniferarum) efficit.

TYPUS GENERIS: *Polyporus peckianus* Cooke, Trans. Proc. bot. Soc. Edinb. 13: 148 (1879).

ÉTYMOLOGIE: à pores jaunes

DESCRIPTION (basée en bonne partie sur Niemelä 1970): Basidiome annuel à prédominance jaune soufre lorsque jeune, brunissant en partie avec l'âge ou au froissement; stipité, à pied central à excentré souvent muni de cordonnets blanchâtres à la base, portant un ou des chapeaux souvent fendus et en entonnoir chez les exemplaires plus âgés ou sinon plus petits et spatulés chez les jeunes chapeaux secondaires superposés, minces et peu charnus; parfois basidiomes soudés; chair à une seule couche et de couleur jaune pâle sur le frais; hyménophore à pores anguleux, 3–6/mm, jaune soufre dès la jeunesse; normalement sans partie distincte orange en herbier avec le temps.

Chair négative au KOH ou au H₂SO₄.

Système hyphal monomitique, à hyphes génératrices plus ou moins bouclées, souvent enflées, à paroi non ou faiblement amyloïde et non dextrinoïde. Éléments gloeopléroïdes présents dans la trame des tubes. Cystides absentes. Hyphes gléoplères présentes dans la chair du chapeau et du pied. Présence d'hyphes oléifères intensément jaunes dans la chair. Basides longuement claviformes, à embranchements en candélabres. Spores, petites, ellipsoïdales à subsphéroïdales, à paroi mince, hyaline, non amyloïde, non dextrinoïde et acyanophile, 3.5–5.6 × 2.5–4 µm. Sporée brun pâle. Champignon saprophyte à carie blanche surtout sur feuillus, mais parfois sur conifères.

REMARQUES: Les *Xanthoporus* se différencient des autres *Scutiger* s. lat. par des basidiomes entièrement jaunes, des hyphes oléifères de la chair intensément jaunes, des basides à embranchements en candélabres (Zmitrovich et al. 2006) et des spores non cyanophiles puis une sporée brun pâle.

Il est intéressant de noter qu'*A. syringae* et *A. peckianus* ont une dominance de jaune et que ce pigment a sûrement une valeur phylogénétique, au même titre que la présence du pigment cinabre chez toutes les espèces du genre *Pycnoporus*. Il est logique de penser que le pigment jaune soit présent dans les hyphes oléifères de la chair qui apparaissent jaune intense dans le NaCl.

Espèces acceptées dans les *Xanthoporus*:

***Xanthoporus peckianus* (Cooke) Audet, comb. nov.**

MYCOBANK MB511093

= *Polyporus peckianus* Cooke, Trans. Proc. bot. Soc. Edinb. 13: 148, 1879.

***Xanthoporus syringae* (Parmasto) Audet, comb. nov.**

MYCOBANK MB511094

= *Scutiger syringae* Parmasto, Bot. Mater. 15: 132 (1962).

REMARQUES: Sur le plan biologique, ce genre cause une carie blanche. *Xanthoporus* fait partie génétiquement d'une famille à carie blanche soit des *Steccherinaceae* (Kim & Jung 2000).

Granmo & Mathiassen (2001b) ont bien résumé l'écologie de *syringae* et *peckianus* en ces termes: « Both species are saprobic, and *A. syringae* probably also can act as a root necrotroph. » Granmo & Mathiassen (2001b) ont également noté des différences supplémentaires les séparant davantage, comme le cutis et les différentes microstructures du pied.

Au sujet d'*Albatrellus*, qui contient *A. peckianus*, Gilbertson & Ryvarden (1986: 87) affirment: « All species have mycorrhizal connections with trees... » et à nouveau mais en étant moins catégoriques (Ryvarden & Gilbertson 1993: 85), sous ce nom qui inclut *A. syringae*, « All species probably have mycorrhizal connections with trees ». Pourtant Niemelä (1970: 56) note pour *A. syringae*: « A positive reaction in gallic acid agar medium suggests that *A. syringae* is one of the species causing white rot », et l'avis de Stalpers (1992) est encore plus clair: « Cultures of *Albatrellus peckianus* and *A. syringae* are good producers of laccase, indicating the ability to degrade lignin. There is no indication of mycorrhiza. » Les espèces qui dégradent la lignine par l'action de la laccase provoquent des caries blanches.

De façon isolée, Boulet (2003) affirme que *peckianus* est un ectomycorhizien non obligé, se référant à Stalpers (1992: 389, cité ci-dessus), et ajoute : « (...) aussitôt germées, les plantules s'allient en symbiose avec ce champignon qui, autrement, ne survit qu'en saprophyte. Les basidiomes sont parfois même accolés aux semis de feuillus. » Cette proximité avec un hôte probable est insuffisante pour avérer l'association mycorrhizique (Brundrett 2004: 485). Cette méthodologie n'est pas reconnue dans la revue des méthodes d'observations mycorrhiziques par Zak (1973: 65–70). En résumé, il n'y a aucune preuve de mycorrhization.

***Xeroceps* Audet, gen. nov.**

MYCOBANK MB 511181

Pileus haud squamosus, basidiosporae ellipsoideae longiores quam 7 µm, haud amyloideae; hyphae generativae normaliter haud fibulatae ac fibulatae.

TYPUS GENERIS: *Scutiger skamanius* Murrill, Mycologia 38: 348 (1946)

ÉTYMOLOGIE: à *chapeau sec*

Basidiome annuel, circulaire à réniforme, à pied central, excentré à latéral portant des chapeaux épais, et charnus, lisses, feutrés ou squamuleux; chair à une seule couche et blanche; hyménophore à pores anguleux, 1–3/mm.

Odeur non caractéristique; saveur douce.

Hyménophore avec nécropigment rougeâtre sur spécimens d'herbier.

Réaction au KOH rouge rosâtre sur toutes les parties (*A. skamanius*), ou chapeau et pied orange rougeâtre puis brun rougeâtre; hyménophore change en rouge vinacé et puis en rose (*A. yunnanensis*). Réaction gris foncé au FeSO_4 (*A. skamanius*). Forte réaction au melzer sur le chapeau et réaction moins forte sur le pied, et négatif sur l'hyménophore (*A. yunnanensis*).

Revêtement du chapeau trichodermique. Système hyphal monomitique, à hyphes lisses ou incrustées, avec larges hyphes gléoplères présentes dans le contexte et dans l'hyménophore, bouclées ou non, à paroi amyloïde ou inamyloïde et non dextrinoïde, à paroi mince. Éléments cystidioïdes (poils au sens de Pouzar 1972) amyloïdes et à paroi épaisse sur le chapeau. Basides longuement claviformes et souvent pédicellées. Spores ellipsoïdales à subsphéroïdales rarement lacrymoïdes, avec large goutte huileuse, à paroi mince, hyalines, inamyloïdes, non dextrinoïdes et cyanophiles, $7.2-11.8(-12.8) \times 5.3-8.0(-8.8) \mu\text{m}$. Sporée probablement blanche. Champignon saprophyte à carie blanche et peut-être ectomycorhizien.

REMARQUES: *Xeroceps* se différencie des vrais *Scutiger* par des chapeaux non écailleux et par des spores généralement ellipsoïdes. Ginns (1997) rapporte une réaction positive avec la syringaldazine pour *Albatrellus skamanius* ce qui indique la présence de laccase extracellulaire.

Espèces acceptées dans *Xeroceps*:

Xeroceps skamania (Murrill) Audet, **comb. nov.**

MYCOBANK MB 511182

≡ *Scutiger skamanius* Murrill, Mycologia 38: 348 (1946)

Xeroceps yunnanensis (H.D. Zheng & P.G. Liu) Audet, **comb. nov.**

MYCOBANK MB511814

≡ *Albatrellus yunnanensis* H.D. Zheng & P.G. Liu, Mycotaxon 97: 146 (2006).

Autre genre ressemblant aux *Scutiger* s. lat.

- *Jahnoporus*

Le genre *Jahnoporus* a pour espèce-type *J. hirtus* qui a une spore fusiforme, un système hyphal monomitique avec hyphes renflées, et qui cause une carie blanche certifiée sur conifères (Chang 1993, 1994; Nobles 1965). Les farnésylphénols (néogrifoline, scutigéral et néogrifolaldéhyde) typiques des *Scutiger* s. lat. sont absents chez *J. hirtus* (Feling 2000), ce qui justifie son exclusion du genre *Scutiger* s. lat.

Seul Boulet (2003) donne des indications contradictoires sur les caries: blanche (p. 84) et brune (p. 520) pour cette espèce. Cette dernière mention est une erreur: « l'espèce se trouve souvent sur des souches fortement décomposées

par des champignons de carie brune mais *J. hirtus* continue durant 2–3 ans seulement » (B. Boulet, comm. pers.).

Même si *J. hirtus* montre des ressemblances morphologiques avec les *Scutiger* s. lat., il n'a aucun nécropigment cinabre en herbier et ne présente aucun élément microscopique amyloïde (spores ou hyphes), au contraire de la très grande majorité de ceux-ci (caractéristique souvent propre aux espèces du clade « russuloïde »; Larsson & Larsson 2003). Ses spores fusiformes ne ressemblent en rien à celles des *Scutiger* s. lat. Aussi, même si Keller (1977) y a trouvé une ultrastructure de paroi de la spore au microscope électronique identique à celles d'*A. cristatus* et d'*A. ovinus*, l'analyse de la FIGURE 1 confirme que cette espèce est sur un clade différent des *Scutiger* s. lat. Le genre *Jahnoporus* est le plus adéquat pour *J. hirtus*.

Le TABLEAU 3, ci-après, donne l'intensité et la localisation des nécropigments se développant avec le temps chez les spécimens d'herbier.

Les nécropigments apparaissent sur les spécimens en herbier avec le temps. Le temps passé en herbier et l'exposition à la naphthaline doivent jouer un rôle sur l'apparition et l'intensité de ceux-ci. Néanmoins, nous avons constaté que les nécropigments représentent un caractère taxinomique très constant. Leur localisation et leur intensité sont utiles pour séparer des espèces éloignées, mais pas pour séparer des espèces trop proches. Par exemple, on ne peut séparer facilement *Albatrellus flettii* d'*A. confluens*. De même, nous n'arrivons pas à séparer sur la base des nécropigments les espèces du groupe d'*Albatrellus ovinus*: *A. ovinus*, *A. citrinus* et *A. subrubescens*.

Il a été rapporté que seule la couleur distingue *A. confluens* et *A. flettii*, mais Ginns (1994, 1997) ne décrit pas de la même façon le pileipellis pour ces deux espèces. Ces différences seraient à confirmer; nos premières analyses microscopiques ont mis en évidence des cristaux pour *A. flettii* et non pour *A. confluens*.

Statut trophique des *Scutiger* s. lat.

Il a été démontré que plusieurs espèces de *Scutiger* s. lat. forment des ectomycorhizes avec différentes essences d'arbres: *Albatrellus avellaneus* (avec bonne indication selon son contenu en azote et carbone isotopique stable) en forêt de *Tsuga heterophylla*, *Pseudotsuga menziesii* et *Picea sitchensis* (Trudell et al. 2004); *Albatrellus* cf. *citrinus* avec *Abies* sp. (Pillukat, comm. pers.). *Albatrellus ovinus* avec *Picea abies* (Agerer et al. 1996); *Laeticutis cristata* européen avec racines de *Castanea sativa* (Bonuso et al. 2007, par alignement des ITS de la séquence de *A. cristatus* UDB001761 de UNITE avec DQ990874 déposée dans GenBank, alignement de 99%); *Albatrellopsis confluens* avec *Picea abies* (Rudawska 2007); *Scutiger ellisii* avec *Abies magnifica* (Bidartondo et al. 2000, sous *Albatrellus* sp. AU. 1 n° AF177704 de GenBank, recouvrement de

TABEAU 3: Nécropigments cinabre des *Scutiger* s. lat. et *Polyporoletus*.

Noms des espèces	Absents	Basidiome	Contexte du chapeau	Tubes	Pied	Contexte du pied
<i>Albatrellopsi confluens</i>		X				
<i>Albatrellopsi flettii</i>		X				
<i>Albatrellus arizonicus</i>		X				
<i>Albatrellus avellaneus</i>					en partie	X
<i>Albatrellus citrinus</i>					en partie	
<i>Albatrellus ovinus</i>				orange pâle	en partie	en partie ¹
<i>Albatrellus subrubescens</i>				orange brunâtre		
<i>Albatrellus tianschanicus</i>	X					
<i>Laeticutis aff. cristata</i>				légèrement		
<i>Laeticutis cristata amér.</i>				X		
<i>Laeticutis cristata eur.</i>	X					
<i>Neoalbatrellus caeruleoporus</i>		variable ¹				
<i>Polyporoletus bulbosus</i>			un peu		en partie	
<i>Polyporoletus sylvestris</i>					en partie	
<i>Polyporoletus sublividus</i> s.l.			X			X
<i>Polypus aff. dispansus</i>				X		
<i>Scutiger ellisii</i>			sous les pores	parfois pâle orange ²		
<i>Scutiger pes-caprae</i>			en partie	saumoné		
<i>Xeroceps skamania</i>			X ²	X		
<i>Xeroceps yunnanensis</i>				X		
<i>Xeroceps peckianus</i>	X					
<i>Xeroceps syringae</i>	X	X ³				

¹ Ginns (1994); ² Ginns (1997); ³ Albee-Scott (2005)

83% avec 100% de similitude avec *Albatrellus ellisii* AD001539 de GenBank); *Polyporoletus sylvestris* (sous *Polyporoletus sublividus*) avec *Abies amabilis* (Agerer et al. 1998).

Il faut s’attendre à ce que les espèces voisines d’espèces attestées comme mycorhiziques soient également mycorhiziennes.

Des affirmations non supportées que certains *Scutiger* s. lat. sont saprophytes.

Seul Boulet (2003) affirme que certains *Scutiger* s. lat. (sous *Albatrellus*) comme *A. caeruleoporus*, *A. confluens* et *A. cristatus* produisent une carie blanche. Pour ce dernier au Québec, l’auteur a cru qu’il s’agissait de *A. cristatus*, mais mes

études micro- et macroscopiques des récoltes ainsi déterminées ont démontré qu’il s’agissait en fait d’*A. ovinus*.

Le fait pour *A. caeruleoporus* de se trouver parfois sur du bois pourri ou près d’une racine morte ne constitue pas une preuve qu’il soit un agent de carie blanche. Il aurait été possible qu’il soit simplement mycorhizique, car il est connu qu’il y a de nombreuses racines à mycorhizer dans ce type de substrat (Henkel et al. 2000) et des *Albatrellus* mycorhiziques ont déjà été inventoriés sur des billes de bois (Edmonds & Lebo 1998). Le fait qu’il produise de la laccase (Marr et al. 1986) lui donne la capacité de produire une carie blanche, mais il est toujours possible qu’il puisse être facultativement mycorhizique.

Pour *A. confluens*, Boulet (2003) mentionne que: « Comme on ne lui connaît pas d’hôte spécifique, ce polypore n’est pas un ectomycorhizique obligé. ». Cependant, sur la base de deux études moléculaires récentes, il a été démontré que la plupart des champignons mycorhiziques dominants sont associés à plusieurs arbres-hôtes (Bruns et al. 2002); de plus il ne produit pas de laccase (Marr et al. 1986). En conséquence, jusqu’à preuve du contraire, *A. confluens* ne cause pas de carie blanche.

Le statut trophique confirmé de certaines espèces de l’étude est présenté dans le TABLEAU 4

TABLEAU 4: Statut trophique

NOMS DES ESPÈCES	MYCORHIZIQUE	CARIE BLANCHE	CARIE BRUNE
<i>Albatrellus avellaneus</i>	X ³		
<i>Albatrellus citrinus</i>	Pillukat, comm. pers.		
<i>Albatrellus ovinus</i>	X ⁵	absente ⁸	
<i>Albatrellopsis confluens</i>	X ¹²	absente ⁸	
<i>Jahnoporus hirtus</i>		X ^{1, 2}	
<i>Laeticutis cristatus</i> eur.	X ^A		
<i>Neoalbatrellus caeruleoporus</i>	possible	X ⁸	
<i>Polypus dispansus</i>	X ⁹		X ⁴
<i>Polyporoletus sylvestris</i>	X ⁶		
<i>Scutiger ellisii</i>	X ¹⁰		
<i>X. peckianus</i>		X ^{7; 11}	
<i>X. syringae</i>		X ^{7; 11}	
<i>Xeroceps skamania</i>		X ¹³	

¹ Nobles (1965)

² Chang (1994)

³ Trudell et al. (2004)

⁴ Canfield (1981)

⁵ Agerer et al. (1996)

⁶ Agerer et al. (1998)

⁷ Granmo A. & Mathiassen. G. (2001a) A. voir informations alignement

⁸ Marr et al. (1986)

⁹ Zheng HD. (2006)

¹⁰ Bidartondo et al. (2000)

¹¹ Stalpers JA. (1992)

¹² Rudawska (2007)

¹³ Ginns (1997)

Clé des genres *Polyporoletus* et *Scutiger* s. lat.

1.	Boucles absentes ou très rares sur les hyphes génératrices du contexte	2
1.	Boucles nombreuses sur les hyphes génératrices du contexte	5
2.	Hyphes du contexte non amyloïdes	3
2.	Certaines hyphes du contexte du chapeau ou de la base du pied amyloïdes	4
3.	Revêtement piléique en hyménoderme	<i>Neoalbatrellus</i>
3.	Revêtement piléique différent	<i>Polypus</i>
4.	Chapeaux dans les tons de brun ou d'olive	<i>Laeticutis</i>
4.	Basidiomes blanchâtres devenant jaunâtres	<i>Albatrellus</i>
5.	Spores avec paroi double	6
5.	Spores sans paroi double	7
6.	Système hyphal dimitique	<i>Polyporopsis</i>
6.	Système hyphal monomitique	<i>Polyporoletus</i>
7.	Spores $\geq 7 \mu\text{m}$	8
7.	Spores $\leq 7 \mu\text{m}$	9
8.	Chapeaux non écailleux	<i>Xeroceps</i>
8.	Chapeaux écailleux	<i>Scutiger</i>
9.	Basidiomes à pores jaunes	<i>Xanthoporus</i>
9.	Basidiomes à pores blancs	<i>Albatrellopsis</i>

**Clé des espèces américaines et européennes des genres proposés
ci-dessus.**

1.	Boucles nombreuses sur les hyphes génératrices du contexte	2
1.	Boucles absentes ou très rares sur les hyphes génératrices du contexte	15
2.	Spores jusqu'à 12(–14) μm de longueur	3
2.	Spores $\leq 7 \mu\text{m}$ de longueur	11
3.	Spores sans paroi double	4
3.	Spores avec paroi double	7
4.	Chapeau brun (frais) ou violet foncé (herbier)	<i>Xeroceps skamania</i>
4.	Chapeau jaune (frais) ou blanc rosâtre à rouge pâle (herbier)	<i>Xeroceps yunnanensis</i>
5.	Chapeau nettement écailleux	6
5.	Chapeau non écailleux	7
6.	Chapeau olive à brun chocolat au lait	<i>Scutiger ellisii</i>
6.	Chapeau brun foncé	<i>Scutiger pes-caprae</i>
7.	Système hyphal dimitique	<i>Polyporopsis</i> (<i>Albatrellus</i>) <i>mexicanus</i>
7.	Système hyphal monomitique	8
8.	Spores d'environ 7.2–10.8 μm de large	9
8.	Spores d'environ 9.6–12.6 μm de large	10

9. Basidiome solitaire et à pied bulbeux. *Polyporoletus bulbosus*
9. Basidiome cespiteux et à pied non bulbeux *Polyporoletus sylvestris*
10. Basidiome avec tubes avortés sur le pied. *Polyporoletus sublividus* s. lat.
10. Basidiome sans tubes avortés sur le pied. 11
11. Certaines hyphes du contexte près de la surface de la base du pied
à paroi épaisse (souvent plus que 0.5 µm); spores petites,
3.5–4.5 × 2.5–3 µm; pores petits, 4–6 par mm *Xanthoporus peckianus*
11. Pas d'hyphes à paroi épaisse près de la surface de la base du pied;
spores plus grandes, 4–5.6 × 3–4 µm; pores plus grands,
3–5 par mm *Xanthoporus syringae*
12. Spores allongées à cylindriques, 4.8–6.4 × 2–2.5 µm. « *Albatrellus* » *pilosus*
12. Spores non cylindriques. 13
13. Hyphes épineuses présentes sur le mycélium et couvrant la base du pied;
spores légèrement amyloïdes. 14
13. Pas d'hyphes épineuses; spores amyloïdes ou non. 15
14. Chapeau de couleur variable sur le frais (chamois, abricot, rarement brunâtre,
etc., sauf bleu) *Albatrellopsis confluens*
14. Chapeau en partie ou complètement bleu sur le frais *Albatrellopsis flettii*
15. Surface du chapeau laquée. *Albatrellus arizonicus*
15. Surface du chapeau non laquée. 16
16. Chapeau avec méchules noires et zone résineuse foncée entre tubes et contexte
. *Albatrellus tianschanicus*
16. Chapeau sans méchules noires 17
17. Basidiome à nombreux chapeaux pétaloïdes arrivant d'une base commune
très ramifiée; chapeau doré au frais *Polypus dispansus*
17. Basidiome à chapeau simple ou confluent 18
18. Majorité des spores plus longues que 5.5 µm *Laeticutis cristata*
18. Majorité des spores plus courtes que 5.5 µm 19
19. Spores inamyloïdes; basidiome surtout orange avec base du pied jaune
en herbier, bleu au frais *Neoalbatrellus caeruleoporus*
19. Spores inamyloïdes ou amyloïdes; basidiome souvent avec teintes de jaune
au frais 20
20. Spores inamyloïdes; sous *Tsuga*, *Picea* ou *Abies* 21
20. Spores distinctement amyloïdes; sous *Pinus* ou *Picea* surtout 22
21. Spores 5–5.6 × 3.6–4.2 µm; sous conifères spécialement *Tsuga* et *Picea*
sur la côte ouest de l'Amérique du Nord *Albatrellus avellaneus*
21. Spores 4.0–4.8 × 3.2–3.8 µm; sous conifères spécialement *Picea* et *Abies*;
largement distribuée. *Albatrellus ovinus*
22. Goût amer ou doux; basidiome jaune ou orange au froissement ou avec l'âge;
sous *Pinus*. *Albatrellus subrubescens*
22. Goût doux; basidiome jaune au froissement; sous *Picea* *Albatrellus citrinus*

Conclusion

Le genre *Scutiger* au sens traditionnel est polyphylétique. La chimiotaxinomie (pigments et autres métabolites secondaires) et la microscopie sont les caractères les plus importants, puis le statut trophique: *Xanthoporus* se caractérise par la production de carie blanche; *Polypus* comme agent de carie brune; *Polypus* et la plupart des autres genres regroupent des espèces mycorhiziques. Les nécropigments ont une valeur taxinomique pour distinguer les genres. Sur le plan microscopique, l'amyloïdie semble plus importante au niveau générique, basée sur la présence ou l'absence chez les hyphes de la chair que leur localisation. La présence ou l'absence de boucles aux hyphes du contexte et les dimensions sporales sont également significatives pour séparer les genres. Chez la famille des *Scutigeraceae* pour les *Scutiger* s. lat. nous avons remarqué qu'il y a régulièrement des éléments cystidioïdes, amyloïdes ou non, sur les chapeaux ou vers la base des pieds. Enfin nous avons remarqué la présence, parfois, de très nombreux cristaux sur les hyphes, dont nous ne connaissons pas encore l'importance taxinomique.

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Références

- Agerer R, Klostermeyer D, Steglich W, Franz F, Acker G. 1996. Ectomycorrhizae of *Albatrellus ovinus* (Scutigeraceae) on Norway Spruce with some remarks on the systematic position of the family. *Mycotaxon* 59: 289–307.
- Agerer R, Beenken L, Ammirati J. 1998. *Polyporoletus sublividus* Snell + *Abies amabilis* Forb. *Descr Ectomyc* 3: 85–91.
- Albee-Scott SR. 2005. The phylogeny and phylogeography of two false-truffles, *Leucophleps spinispora* and *Hymenogaster sublilacinus*, in the Great Basin, United States. University of Michigan. Diss. 159 p.
- Albee-Scott SR. 2007. The phylogenetic placement of the *Leucogastrales*, including *Mycolevis siccigleba* (Cribbeaceae), in the *Albatrellaceae* using morphological and molecular data. *Mycol. Res.* 111 (6): 653–662.
- Bernicchia A. 1990. *Polyporaceae s.l.* in Italia. Istituto di Patologia Vegetale Università degli Studi: Bologna (Italia). 594 p.
- Bidartondo MI, Kretzer AM, Pine EM, Bruns TD. 2000. High root concentration and uneven ectomycorrhizal diversity near *Sarcodes sanguinea* (Ericaceae): A cheater that stimulates its victims? *American Journal of Botany* 87(12): 1783–1788.
- Bondartsev [Bondartsew] AS, Singer R. 1941. Zur systematik der *Polyporaceae*. *Ann. mycol.* 39: 43–65.
- Bonuso E, Klotz P, Lotti M, Peintner U, Zambonelli A. 2007. Soil fungal communities in a *Castanea sativa* (chestnut) forest producing large quantities of *Boletus edulis* sensu lato (porcini): where is the mycelium of porcini? *Environmental Microbiology* 9(4): 880–889.
- Boulet B. 2003. Les champignons des arbres de l'est de l'Amérique du Nord. Les publications du Québec: Québec (Canada). 727 p.
- Brundrett M. 2004. Diversity and classification of mycorrhizal associations. *Biological Reviews* 78: 473–495.
- Bruns TD, Szaro TM, Cullings KW, Pan JJ, Taylor DL, Horton TR, Kretzer A, Garbelotto M, Li Y. 1998. A sequence database for the identification of ectomycorrhizal basidiomycetes by phylogenetic analysis. *Mol. Ecol.* 7: 257–272.
- Bruns TD, Bidartondo MI, Taylor DL. 2002. Host specificity in ectomycorrhizal communities: What do the exceptions tell us? *Integrative and Comparative Biology* 42(2): 352–359.
- Canfield ER. 1981. The wood decay capability of *Albatrellus dispansus*. *Mycologia*. 73(3): 399–406.
- Chang TT. 1993. Seven wood-inhabiting *Aphylllophorales* (Basidiomycota) new to Taiwan. *Bot. Bull. Acad. Sin.* 34: 183–190.
- Chang TT. 1994 Some new Taiwan polypores (*Basidiomycotina*). *Trans. Mycol. Soc. ROC* 9(2): 111–122.
- Coelho G, Cortez VG, Guerrero RT. 2007. New morphological data on *Amauroderma brasiliense* (*Polyporales*, *Basidiomycota*). *Mycotaxon* 100: 177–183.
- Cooke WB. 1940. A nomenclatorial survey of the genera of pore fungi. *Lloydia (Cincinnati)* 3(2): 81–104.
- Corner EJH. 1989. *Ad Polyporaceas V. Beih. Nova Hedwigia* 96. 218 p.
- Cui BK, Wang Z, Dai YC. 2008. *Albatrellus piceiphilus* sp. nov. on the basis of morphological and molecular characters. *Fungal Diversity* 28: 41–48.
- Edmonds RL, Lebo DS. 1998. Diversity, production and nutrient dynamics of fungal sporocarps on logs in an old-growth temperate rain forest, Olympic National Park, Washington. *Canadian Journal of Forest Research* 28(5): 665–673.
- Elrod RP, Blanchard L. 1939. Histological studies of the *Boletaceae* and related genera. *Mycologia* 31: 693–708.

- Feling N. 2000. Chemotaxonomische Untersuchungen und Strukturaufklärung von Sekundärmetaboliten aus Pilzen der Gattungen *Albatrellus*, *Polyporoletus*, *Jahnoporus* (*Basidiomycetes*) sowie *Hypoxylon* (*Ascomycetes*). Fak. für Chemie und Pharmazie: München, Univ. (Germany) Diss. 176 p.
- Gilbertson RL, Ryvarden L. 1986. North American Polypores. Synopsis Fungorum 1 Fungiflora: Oslo (Norway). 435 p.
- Ginns J. 1994. *Albatrellus* (*Fungi: Basidiomycota*) in Michigan. Michigan Botanist 33: 75–90.
- Ginns J. 1997. The taxonomy and distribution of rare or uncommon species of *Albatrellus* in western North America. Can. J. Bot. 75: 261–273.
- Granmo A, Mathiassen G. 2001a *Albatrellus syringae* (*Albatrellaceae*) in Fennoscandia and the Baltic region: ecology and distribution. Karstenia 41: 37–48
- Granmo A, Mathiassen G. 2001b: *Albatrellus syringae* and *A. peckianus* (*Albatrellaceae*): taxonomic remarks and world distribution. Karstenia 41: 49–54.
- Hawksworth DL. 1984. (758–774) Proposals for nomina conservanda and rejicienda for names of hymenomycetes necessary as a result of the change in starting point date for the nomenclature of fungi. Taxon 33(4): 730–736.
- Hawksworth DL, Kirk PM, Sutton BC, Pegler DN. 1995. Ainsworth & Bisby's. Dictionary of the Fungi. 8e édit., CAB International: Surrey (UK). 616 p.
- Henkel TW, Aime MC, Miller SL. 2000. Systematics of pleurotoid *Russulaceae* from Guyana and Japan, with notes on their ectomycorrhizal status. Mycologia 92(6): 1119–1132.
- Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Huelsenbeck JP, Ronquist FR. 2001. MrBayes: Bayesian inference of phylogeny. Biometrics 17: 754–755.
- Johannesson H, Renvall P, Stenlid J. 2000. Taxonomy of *Antrodiella* inferred from morphological and molecular data. Mycol Res 104: 92–99.
- Keller J. 1977. Ultrastructure des parois sporiques des *Aphylllophorales*, III. *Albatrellus hirtus* (Quél.) Donk. Bulletin Suisse de Mycologie 55(4): 58–61.
- Kim SY, Jung HS. 2000. Phylogenetic relationships of the *Aphylllophorales* inferred from sequence analysis of nuclear small subunit ribosomal DNA. The Journal of Microbiology 38(3): 122–131.
- Kotlaba F, Pouzar Z. 1957. Notes on classification of European pore fungi. Česká Mykol. 11: 152–170.
- Laferriere JE, Gilbertson RL. 1990. A new species of *Albatrellus* (*Aphylllophorales: Albatrellaceae*) from Mexico. Mycotaxon 37: 183–186.
- Larsson E, Larsson KH. 2003. Phylogenetic relationships of russuloid basidiomycetes with emphasis on aphylllophoralean taxa. Mycologia 95: 1037–1065
- Lutzoni et al. 2004. Assembling the fungal tree of life: progress, classification, and evolution of subcellular traits. Am. J. Bot. 91: 1446–1480.
- Marr CD, Grund DW, Harrison KA. 1986. The taxonomic potential of laccase and tyrosinase spot tests. Mycologia 78: 169–184.
- Miller SL, Larsson E, Larsson K-H, Verbeken A, Nuytinck J. 2006. Perspectives in the new *Russulales*. Mycologia 98: 960–970.
- Murrill WA. 1905. The *Polyporaceae* of North America. XII. A synopsis of white and bright-colored pileate species. Bull. Torrey Bot. Club 32(9): 469–493.
- Niemelä T. 1970. New data on *Albatrellus syringae* and *Albatrellus peckianus*, new combination. Annales Botanici Fennici 7(1): 52–57.

- Nobles MK. 1965. Identification of cultures of wood-inhabiting hymenomycetes. *Can. J. Bot.* 43: 1097–1139.
- Nuss I. 1980. Untersuchungen zur systematischen Stellung der Gattung *Polyporus*. *Hoppea* 39: 127–198.
- Overholts LO. 1953. The *Polyporaceae* of the United States, Alaska and Canada. Ann Arbor, The University of Michigan Press. 466 p.
- Paulet J-J. 1793 (publié en 1808). *Traité des champignons*. Imprimerie nationale exécutive du Louvre. Paris. Vol. I, 629 p., vol. II, 476 p. <http://www.archive.org/details/traitedschampign02paul>
- Paulet J-J. 1808 *Prospectus du Traité des champignons*. (Publication séparée, reliée au début d'une partie des exemplaires du *Traité des champignons*.)
- Paulet J-J. 1808-1835. *Iconographie du Traité des champignons*. Imprimerie de Mme Huzard (pour tout ou partie des planches). Paris.
- Pegler DN. 1967. *Polyporaceae*—part II. With a key to world genera. *Bulletin of British Mycological Society*. 1(1): 17–36.
- Pieri M, Rivoire B. 2002. A propos du genre *Scutiger*. *Bull. Soc. mycol. France* 118(1): 31–47.
- Pouzar Z. 1966. A new species of the genus *Albatrellus* (*Polyporaceae*). *Folia Geobot. Phytotaxonomica* 1: 274–276.
- Pouzar Z. 1972. Contribution to the knowledge of the genus *Albatrellus* (*Polyporaceae*) I. A conspectus of species of the North Temperate Zone. *Česká Mykologie* 26(4): 194–200.
- Rudawska M. 2007. Mycorrhiza. In: *Biology and Ecology of Norway spruce*, Eds: MG Tjoelker, A Boratyński, W Bugała; Springer. *Forest Sciences* 78:157–182
- Ryman S, Fransson P, Johannesson H, Danell E. 2003. *Albatrellus citrinus* sp. nov. connected to *Picea abies* on lime rich soils. *Mycol. Res.* 107(10): 1243–1246.
- Ryvarden L. 1991. Genera of polypores. *Nomenclature and taxonomy*. *Synopsis Fungorum* 5 *Fungiflora*: Oslo (Norway). 363 p.
- Ryvarden L, Gilbertson RL. 1993. European polypores 1: *Abortiporus* – *Lindtneria*. *Synopsis Fungorum* 6. *Fungiflora*: Oslo (Norway). 387 p.
- Ryvarden L, Johansen I. 1980. A preliminary polypore flora of east Africa. *Fungiflora*: Oslo (Norway). 636 p.
- Singer R. 1969. *Mycoflora Australis*. Beihefte zur Nova Hedwigia 29: 405 p.
- Singer R, Snell WH, White WL. 1945 The taxonomic position of *Polyporoletus sublividus*. *Mycologia* 37: 124–128.
- Snell WH. 1936. Notes on boletes – V. *Mycologia* 28: 463–475.
- Stalpers JA. 1992. *Albatrellus* and the *Hericiaceae*. *Persoonia* 14: 537–541.
- Stefani FOP, Bérubé JA. 2006. Biodiversity of foliar fungal endophytes in white spruce (*Picea glauca*) from southern Québec. *Can. J. Bot.* 84: 777–790.
- Teixeira AR. 1993. Chava para identificação dos gêneros de *Polyporaceae* com base na morfologia do basidiocarpo. *Bol. Inst. Botânica* 8: 1–55.
- Trudell SA, Rygiewicz PT, Edmonds RL. 2004. Patterns of nitrogen and carbon stable isotope ratios in macrofungi, plants and soils in two old-growth conifer forests. *New Phytologist* 164(2): 317–335.
- Zak B. 1973. Characterization of ectomycorrhizae. In Marks GC, Kozlowski, TT. (eds) *Ectomycorrhizae – their ecology and physiology*. Academic Press: New York (USA): 43–78.
- Zheng HD. 2006. Studies on the Taxonomy and Phylogeny of *Albatrellaceae* Nuss (*Polyporales*, *Basidiomycetes*, *Basidiomycota*). (chinois). Diss. 220 p.
- Zheng HD, Liu PG. 2006. *Albatrellus yunnanensis*, a new species from China. *Mycotaxon* 97: 145–151.
- Zmitrovich IV, Malysheva VF, Wjacheslav AS. 2006. A new morphological arrangement of the *Polyporales* s.l. *Phanerochaetinae*. *Mycena* 6: 4–56.

TABLEAU 5. Noms d'espèces, récoltes et numéros d'accessions GenBank ^a

NOM ADOPTÉ	NOM D'ÉCHANTILLON	HERBIER	N° DE RÉCOLTE	SÉQUENCES ITS	SÉQUENCES RLSU
<i>Abortiporus biennis</i>	<i>Abortiporus biennis</i>				AJ406527
<i>Albatrellus citrinus</i>	<i>Albatrellus citrinus</i>			AY198197	
<i>Albatrellus citrinus</i> <i>s. lat.</i>		HKAS	457729	Zheng 2006	
<i>Albatrellus ovinus</i>	<i>Albatrellus ovinus</i>	QFB	7990	(FJ439515)	AY293165
<i>Albatrellus subrubescens</i>	<i>Albatrellus subrubescens</i>			AY198208	AY293166
<i>Albatrellus tianschanicus</i>		HKAS	33597	Zheng 2006	
<i>Albatrellus yunnanensis</i>		HKAS	48311	Zheng 2006	
<i>Albatrellopsis confluens</i>	<i>Albatrellus confluens</i>	HKAS	48292	Zheng 2006	AY293163
<i>Albatrellopsis flettii</i>	<i>Albatrellus flettii</i>			AY061738 AY621802	AF518596
<i>Antrodiella semisupina</i>	<i>Antrodiella semisupina</i>				AY293167
<i>Byssoporia terrestris</i>	<i>Byssoporia terrestris</i>				DQ389664
<i>Diplomitoporus crustulinus</i>	<i>Diplomitoporus crustulinus</i>			AF343320	
<i>Grifola frondosa</i>	<i>Grifola frondosa</i>				AY826982
<i>Jahnoporus hirtus</i>	<i>Jahnoporus hirtus</i>	QFA	285741	(FJ439517)	DQ911606
<i>Laeticutis cristata</i>	<i>Albatrellus cristatus</i>				AY293164
<i>Lentinus tigrinus</i>	<i>Lentinus tigrinus</i>				AY615974 AY615977
<i>Leucogaster citrinus</i>	<i>Leucogaster citrinus</i>				2341LSU (S. Miller)
<i>Leucogaster microsporus</i>	<i>Leucogaster microsporus</i>				2340LSU (S. Miller)
<i>Albatrellopsis confluens</i>	<i>Leucogaster rubescens</i>			AY907544	
<i>Meripilus giganteus</i>	<i>Meripilus giganteus</i>				AJ406537
<i>Mycolevis siccigleba</i>	<i>Mycolevis siccigleba</i>				380LS69 (S. Miller)
<i>Neoalbatrellus caeruleoporus</i>	<i>Albatrellus caeruleoporus</i>			AY963565	
<i>Neoalbatrellus yasudae</i>		HKAS	357766	Zheng 2006	
<i>Pleurotus tuber-regium</i>	<i>Pleurotus tuber-regium</i>			AF109985	
<i>Polyporoletus bulbosus</i>	<i>Polyporoletus sublividus</i>			AY963568	

TABLEAU 5 (fin).

NOM ADOPTÉ	NOM D'ÉCHANTILLON	HERBIER	N° DE RÉCOLTE	SÉQUENCES ITS	SÉQUENCES RLSU
<i>Polyporoletus sylvestris</i>	<i>Polyporoletus sublividus</i>	DAOM	221078	(FJ439518)	AF393066
<i>Polyporus tuberaster</i>	<i>Polyporus tuberaster</i>				AF261544
<i>Polypus dispansus</i>	<i>Albatrellus dispansus</i>	NY	7979	(FJ439516)	EF551312
<i>Scutiger ellisii</i>	<i>Albatrellus ellisii</i>			AY621803	
<i>Scutiger pes-caprae</i>	<i>Albatrellus pes-caprae</i>	QFB	7993	(FJ439514) consensus	AF506394
<i>Steccherinum fimbriatum</i>	<i>Steccherinum fimbriatum</i>				AF518651
<i>Xanthoporus peckianus</i>	<i>Albatrellus peckianus</i>	QFB	7987	(FJ439513)	
<i>Xanthoporus syringae</i>	<i>Albatrellus higanensis</i>			AY789078	
<i>Xanthoporus syringae</i>	<i>Albatrellus syringae</i>	QFB	7994	AY198209 (FJ439519)	AF393045
<i>Xeroceph skamania</i>	<i>Albatrellus skamanius</i>				AF393044

^a Les nouvelles séquences ont leurs numéros entre parenthèses.

A new species of *Marcelleina* from Italy

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Abstract — *Marcelleina mediterranea* is described as a new species and is illustrated. It occurs on sandy soil among scattered mosses, in Southeast Sicily (Italy). It differs from other species in size and ornamentation of ascospores. Its ecology and taxonomical relationships are examined.

Key words — *Pezizales*, *Pyronemataceae*, morphology, taxonomy

Introduction

A peculiar *Marcelleina* species was found growing on sandy soil among scattered mosses during field investigation in southeastern Sicily, in the Riserva Naturale Orientata Sughereta di Niscemi (Caltanissetta). The large reserve, nearly 3000 hectares, centers on the remnants of what was previously the largest cork center in Sicily. This well delimited new *Marcelleina* species is described below as *M. mediterranea*. The genus, which previously was referred to the *Pyronemataceae*, is now treated in the *Pezizaceae* based on molecular data (Hansen et al. 2001). Approximately ten species are now recognized in *Marcelleina*.

Materials and methods

This study is based on field collections made in the winter of 2008 in an area that extends in altitude from between 50 and 350 m. The area is characterized by the presence of *Quercus suber* L. with shrubby Mediterranean elements including *Cistus creticus* L., *C. monspeliensis* L., *C. salvifolius* L., and *Pistacia lentiscus* L.

Morphologic and microscopic examinations were carried out on fresh material and on dried specimens, which were rehydrated in water. Observations and measurements were made in water and Melzer's reagent to observe ascus reactions and colour changes in the pigments within the paraphyses. Sizes of excipular cells, spores, and paraphyses were reported from the measurement of 50 individual structures, using an Optika

optical microscope (model BK 1301), with 40× or 100× (oil immersion) objectives. All voucher specimens cited below are deposited in the herbarium of the Royal Botanic Gardens, Kew K(M) and in the Farlow Herbarium, Harvard University (FH).

Taxonomy

Marcelleina mediterranea Lantieri & Pfister, sp. nov.

FIGURE 1

MYCOBANK MB 516039

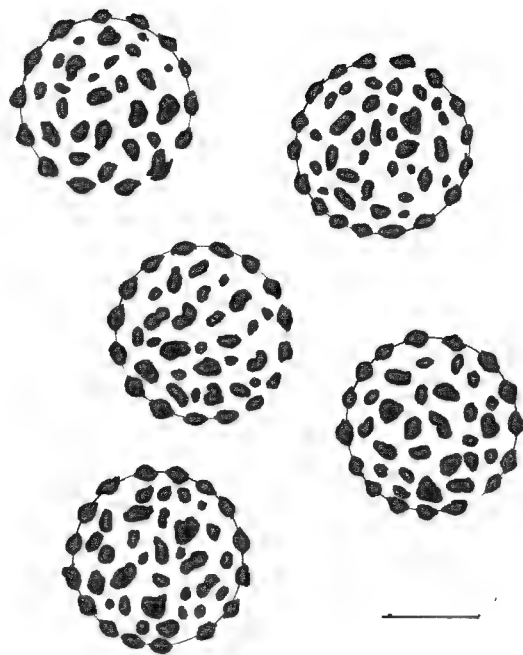
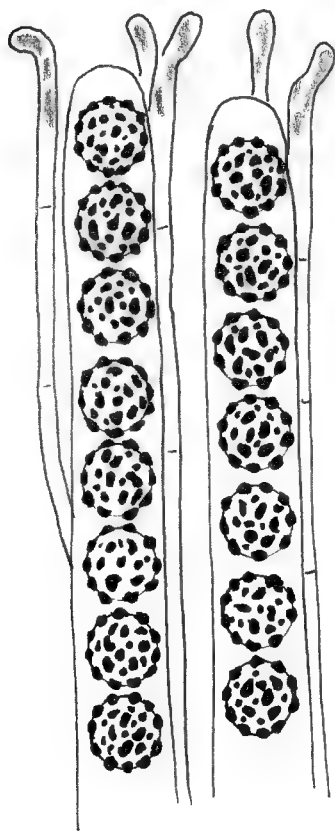
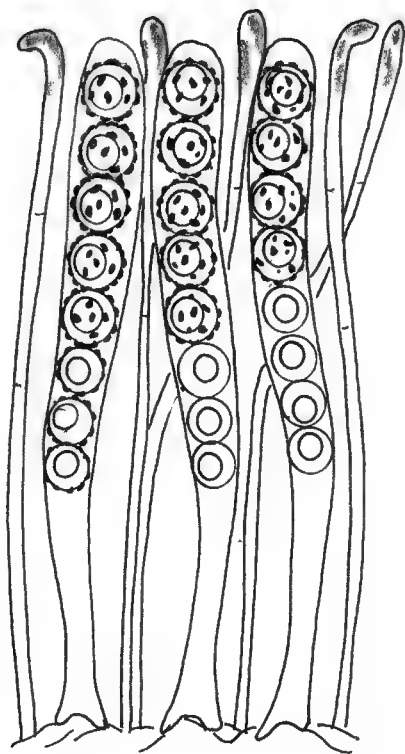
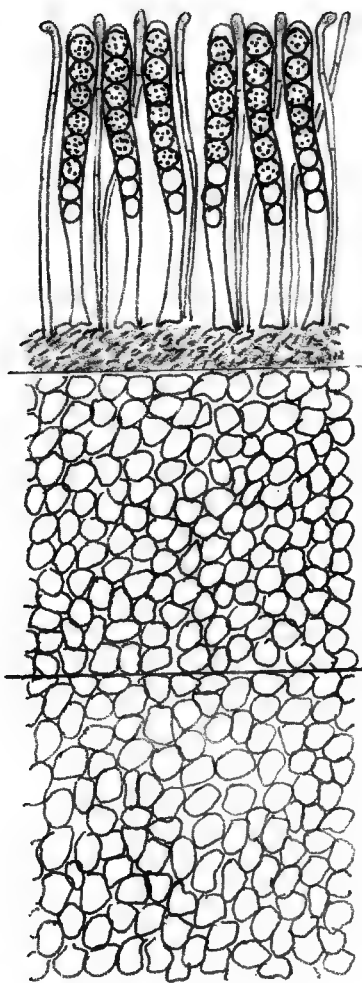
Apothecia 3–5 mm diam., sessilia, discoidea vel applanata, hymenium obscure violaceum vel nigroviolaceum; externe glabrum, concolor; margine perspicuo, plus minusve undulato. Ascospores (13–)14–18 µm diam., sine ornamentis, uniseriatae, globosae, hyalinae, uniguttulatae, tuberculis circa 1 µm altis et circa 2 µm latis praeditae. Asci 250–300 × (15–)18–19 µm, cylindracei vel leviter cylindrico-clavati, inamyloidei, octaspori, basi pleurorhynca praediti, nonnulli basi irregulari et simplici. Paraphyses raras, leviter claviformes, in superiore parte inflatae usque ad 5–6 µm, curvatae, septatae, pigmento brunneolo. Hymenium 290(–300) µm altum, superne brunneoviolaceum, inferne albidobrunneolum; subhymenium brunneolum, 60–80 µm crassum; medullare excipulum 150–300 µm crassum, griseobrunneolum, textura globulosa, cellulis pallide brunneis, tenuitunicatis, globosis vel subglobosis, usque ad 5 m diam. vel longioribus, 5–18 × 12 µm; ectal excipulum 50 µm crassum ad margines, 370 µm crassum ad basin, textura globulosa vel globulosa-angulari, cellulis obscure brunneis, tenuitunicatis, globosis, subglobosis vel plus minusve polygonalibus, usque ad 30 µm diam., nonnullis longioribus, 45–50 × 30 µm; paucis hyphis septatis intermixtis, circa 5 µm diam.

HOLOTYPE: ITALY, SICILY: in loco “Sughereta of Niscemi” dicto, prope Caltanissetta, in solo sabuloso, parce gregarius vel solitarius, inter muscos sparsos iuxta Cistum creticus, C. monspeliensem, C. salvifolius et Pistaciam lentiscus, 31/01/08, lectus, legit A. Lantieri, in Herbario FH, sub n. 00284462 conservatur; isotypus n. 164532 in Herbario KM conservatur.

ETYMOLOGY: *Mediterranea* referring to the Mediterranean area, where the species was found.

APOTHECIA 3–5 mm diam., sessile, discoid to flattened, **HYMENIUM** dark violaceous to black-violaceous; **OUTSIDE** glabrous, concolorous; margin evident, more or less undulate. **ASCOSPORES** (13–)14–18 µm diam. (without ornamentations), uniseriate, globose, hyaline, uniguttulate, tubercles about 1 µm high and about 2 µm wide. **ASCI** 250–300 × (15–)18–19 µm, cylindrical or slightly cylindrical-clavate, non-amyloid, 8-spored, with a pleurorhyncous base, a few asci have irregular and simple bases. **PARAPHYSES** scarce, slightly claviform, expanded in the upper part up to 5–6 µm, curved, septate, containing brownish pigments. **HYMENIUM** 290(–300) µm high, brown-violaceous in the upper part, whitish-brownish in the lower regions. **SUBHYMENIUM** brownish

FIGURE 1. *Marcelleina mediterranea*: A Radial section through the excipulum and hymenium of an apothecium. Scale bar = 50 µm. B Uppermost zone of the hymenium (tips of paraphyses and asci with ascospores). Scale bar = 10 µm. C Apical section of the hymenium with asci and paraphyses. Scale bar = 10 µm. D Released ascospores. Scale bar = 60 µm.



60–80 µm thick. MEDULLARY EXCIPULUM 150–300 µm thick, grey-brownish, of textura globulosa, cells brown pale, thin-walled, globose or subglobose, up to 5 µm diam., or longer, and then 5–18 × 12 µm. ECTAL EXCIPULUM 50 µm thick at the margins, 370 µm thick toward the base, of textura globulosa or globulosa-angularis, cells dark-brown, thin-walled, globose, subglobose or more or less polygonal, up to 30 µm diam., some cells appear longer, of 45–50 × 30 µm and intermixed with scarce interwoven septate hyphae, about 5 µm diam.

HABITAT: on sandy soil, in small groups or solitary, among scattered mosses near *Cistus creticus*, *C. monspeliensis*, *C. salvifolius* and *Pistacia lentiscus*; in winter.

KNOWN DISTRIBUTION: Italy.

ADDITIONAL SPECIMEN EXAMINED – ITALY. SICILY: Niscemi (Caltanissetta), 06/02/2008, K(M) 164533.

Discussion

This species is referred to *Marcelleina* based on its small purplish apothecia with light brown pigments in the hyphal walls of the outer excipulum and its hyaline spores; *M. mediterranea* differs from other described species of the genus in ascospore size and ornamentation.

The new species resembles *M. tuberculispora* K. Hansen & Sandal, described from Denmark, but this latter species has smaller (11.3–12.5 µm diam.) ascospores with dense, rounded warts variably sized up to 1.3 µm high (Hansen et al. 1998). Furthermore, *M. tuberculispora* grows on calcareous soil, which is not found where *M. mediterranea* was collected.

Marcelleina pseudoanthracina (Donadini) R. Kristiansen & J. Moravec differs from *M. mediterranea* in having smaller (7–8.5 µm diam.) ascospores with irregularly rounded to angular, isolated or scattered warts up to 0.5 µm high (Moravec 1987) and in its habitat – *M. pseudoanthracina* generally grows on clayey soil or sometimes also burnt places.

The new species has been found in Mediterranean area, near *Cistus creticus*, *C. monspeliensis*, *C. salvifolius* and *Pistacia lentiscus*, which are typical elements on the sandy soil of the Mediterranean bush. *Marcelleina mediterranea* is a species that fruits from the last week of January to the first two weeks of February. Tedersoo et al. (2009) delimit a lineage including *Marcelleina*, *Peziza gerardii*, and *Hydnobolites* that is mycorrhizal. Certainly in this case several mycorrhizal partners might be present.

Acknowledgements

The authors sincerely thank to Prof. G. Consiglio (Italy) for the Latin diagnosis, and Prof. Gabriel Moreno (Spain) and Prof. Zheng Wang (USA) for critically reviewing the manuscript.

Literature cited

- Hansen K, Sandal SK, Dissing H. 1998. New and rare species of *Pezizales* from calcareous woodlands in Denmark. *Nordic Journal of Botany* 18 (5): 611–626.
- Hansen K, Læssøe T, Pfister DH. 2001. Phylogenetics of the *Pezizaceae*, with an emphasis on *Peziza*. *Mycologia* 93: 958–990.
- Moravec J. 1987. A taxonomic revision of the genus *Marcelleina*. *Mycotaxon* 30: 473–499, pl. fig. 1–4.
- Tedersoo L, May TW, Smith ME. 2009. Ectomycorrhizal lifestyle in fungi: global diversity, distribution and evolution of phylogenetic lineages. *Mycorrhizae* DOI 10.1007/s00572-009-0274-x.

A new species of *Aschersonia* (*Clavicipitaceae*, *Hypocreales*) from China

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Abstract — A new species of the *Clavicipitaceae*, *Aschersonia macrostromatica*, collected from Hainan Province of China is described and illustrated. This fungus differs from other related *Aschersonia* species in its brownish-yellow, globose, tubercular, large stromata and absence of ostiolar openings, paraphyses, and hypothallus.

Key words — morphology, taxonomy, entomogenous fungus

Introduction

The genus *Aschersonia* Mont. (*Clavicipitaceae*, *Hypocreales*) was established and typified with *A. taitensis* Mont. from the tropics (Montagne 1848). Forty-four species are currently accepted in *Aschersonia* (Chaverri et al. 2005). The genus is characterized by pycnidia that range from cupulate depressions to locules totally immersed in pulvinate to globose stromata that are typically brightly colored, fleshy and unicellular, fusiform, hyaline phialoconidia that are extruded from the locules in brightly colored waxy cirrhi (Petch 1921, 1925, Mains 1959). The only known teleomorphs are in the genera *Hypocrella*, *Moelleriella*, and *Samuelsia*, all members of the *Clavicipitaceae* (*Hypocreales*, Chaverri et al. 2008). All species are parasites of scale insects.

During an investigation on the diversity of microfungi in Hainan Province of China, an interesting entomogenous fungus was found in Xinglong Tropical Botanical Garden. The general morphological characteristics of globose pycnidia formed in hemispherical or cushion-shaped (pulvinate) stroma, slender branched conidiophores, hyaline, mostly fusoid, and smooth one-celled conidia and parasitism on homopteran insects fit the generic concept for *Aschersonia* well. The short fusoid conidia and brownish-yellow tubercular

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stromata, and the absence of paraphyses and hypothallus are the main features to distinguish this fungus from other known species in the genus.

Materials and methods

The specimens of the species studied were deposited at the Mycology Herbarium of Fujian Agricultural and Forestry University (MHFAFU). Morphological characters of three collections were studied at different developmental stages. The microscopic features and measurements of the fungus were examined with the aid of a light microscope and a stereoscope by the method presented by Qiu et al. (Qiu et al. 2009). Sections of the conidiomata were mounted in water on a slide. Twenty pycnidia and specimens were measured using an ocular micrometer. Special colour terms are from Kornerup & Wanscher (1967).

Taxonomy

Aschersonia macrostromatica Jun Z. Qiu & Xiong Guan, sp. nov.

FIGS. 1A–F

MYCOBANK MB 514149

Stromata magna, hypothallus nullus, 2–5 mm lata, 1–4 mm alta, hemisphaerica, flava, subglobosa, cerebriformia, superfacie laevia, aliquantum nitida, in vivo carnosa, in sicco dura, convoluta vel tuberculata, brunneola, superfacie aliquot orificiis ut punctis minutis visibilibus praedita. Pycnidia immersa in stromatibus, irregularia, 86–172 µm alta, 66–106 µm lata, aparaphysata. Conidia hyalina, laevia, fusiformia, unicellularia, 5–8.2 × 1–1.6 µm, cirrhi mucosi.

TYPE — J.Z. Qiu & X. Guan 334, MHFAFU 20804 (**holotype**) on *Coccidae*; Xinglong Tropical Garden, Hainan Prov., Wanning County, Xinglong, China, alt. 300 m, 26.X.2008.

ETYMOLOGY — Refers to the large stroma.

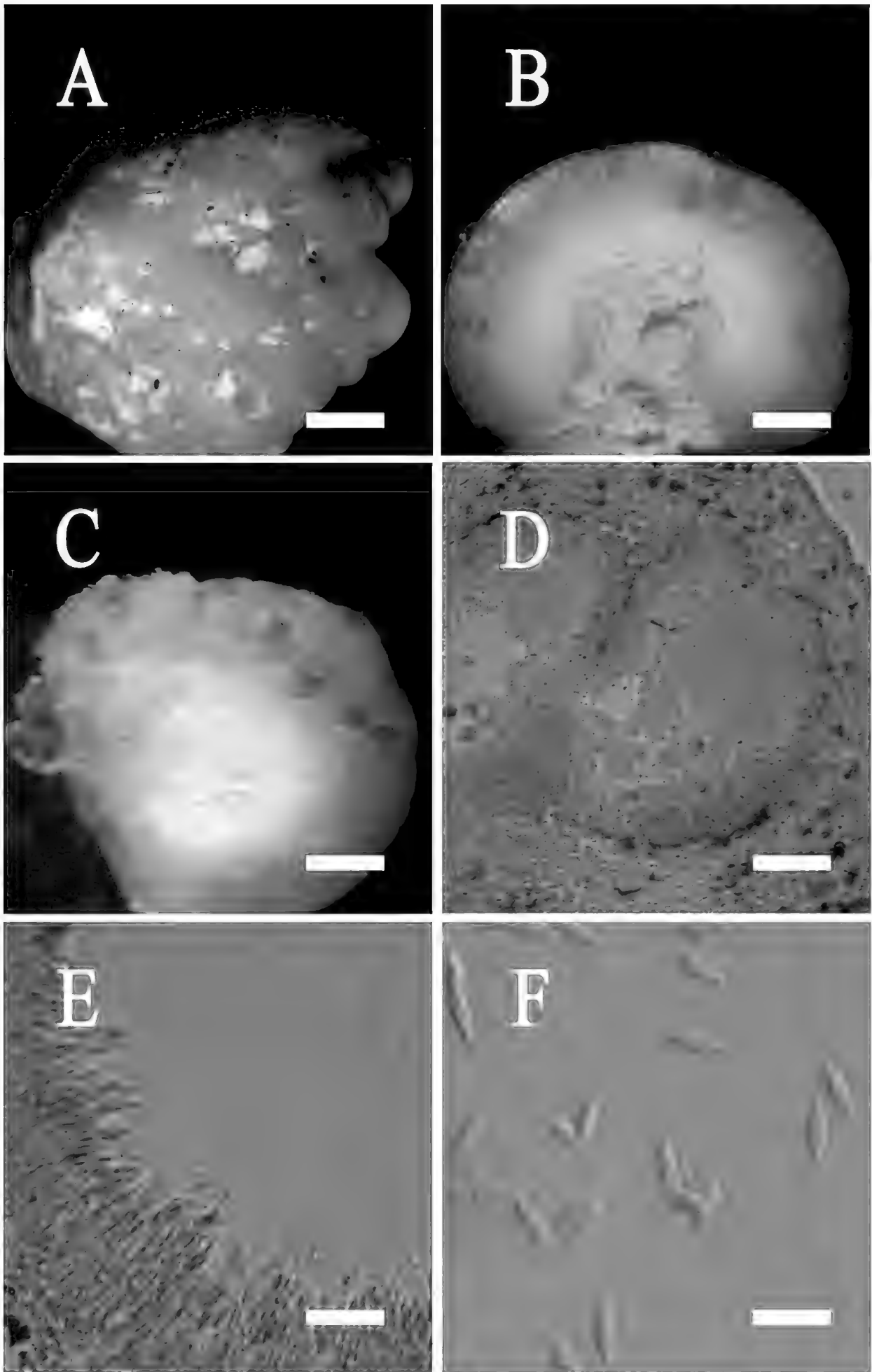
TELEOMORPH: None known.

STROMATA large, lacking a hypothallus, 2–5 mm diam, 1–4 mm high, hemispherical, yellow, somewhat globose, cerebriform, surface smooth, somewhat glossy, fleshy when fresh but hard when dry, convoluted or tuberculate, 8–45 ostiolar openings as minute dots visible over the surface, covered with conidial masses brownish-yellow. PYCNIDIA immersed in stroma, irregular in shape, 86–172 × 66–106 µm. PARAPHYSES absent. CONIDIA hyaline, smooth, fusiform, unicellular, cirri slimy, 5–8.2 × 1–1.6 µm.

COMMENTS—*Aschersonia macrostromatica* is characterized by large, globose, tubercular, brownish-yellow stromata, ostiolar openings, small conidia, and lack of paraphyses and hypothallus. Four species of *Hypocrella* — i.e.,

FIG.1 *Aschersonia macrostromatica*. A: Stroma; B: Cross-section of stroma showing stylet hole; C: Section of stroma; D: Globose conidioma with hymenium and conidia; E: Phialides and conidiogenous cells extending above the hymenium; F: Conidia.

Scale bars: A,B,C = 1 mm; D,E = 50 µm; F = 10 µm.



H. africana Hywel-Jones & Samuels from Liberia, *H. gaertneriana* Möller from tropical South America (Brazil, French Guiana, Venezuela), *H. schizostachyi* Henn. from Southeast Asia (Philippines, Thailand), and *H. macrostroma* P. Chaverri & K.T. Hodge from Bolivia and Costa Rica — also have large stromata and grow on scale insects (Chaverri et al. 2005, 2008). Although related to these four species, *A. macrostromatica* is distinguished by having markedly smaller (ca. 2–5 mm diam) stromata.

Aschersonia macrostromatica has very small conidia ($5\text{--}8.2 \times 1\text{--}1.6 \mu\text{m}$) that are similar in size to those of *Aschersonia australiensis* Henn. and *Aschersonia minutispora* Hywel-Jones & Mongkolsamrit (Petch 1921, Mongkolsamrit et al. 2009). However, the significant difference separating *A. macrostromatica* from *A. australiensis* and *A. minutispora* are the larger stromata and the existence of a hypothallus and paraphyses in the latter two species. Furthermore, *A. macrostromatica* stromata are large (up to 5 mm diam) for *Aschersonia* and larger than those of *A. minutispora* (up to 1.5 mm diam) and *A. australiensis* (up to 2 mm diam).

Acknowledgements

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Literature cited

- Chaverri P, Bischoff JF, Liu M, Hodge KT. 2005. A new species of *Hypocrella*, *H. macrostroma*, and its phylogenetic relationships to other species with large stromata. *Mycol. Res.* 109(11): 1268–1275.
- Chaverri P, Liu M, Hodge KT. 2008. A monograph of the entomopathogenic genera *Hypocrella*, *Moelleriella* and *Samuelsia* gen nov. (*Ascomycota*, *Hypocreales*, *Clavicipitaceae*), and their anamorphs in the Neotropics. *Stud. Mycol.* 60: 1–66.
- Kornerup A, Wanscher JH. 1967. *Methuen handbook of colour*. Methuen, London.
- Mains EB. 1959. Species of *Aschersonia* (*Sphaeropsidales*). *Lloydia* 22(3): 215–221.
- Mongkolsamrit S, Luangsa-Ard JJ, Spatafora JW, Sung GH, Hywel-Jones NL. 2009. A combined ITS rDNA and beta-tubulin phylogeny of Thai species of *Hypocrella* with non-fragmenting ascospores. *Mycol. Res.* 113(6–7): 684–699.
- Montagne JPFC. 1848. Sixième centurie de plantes cellulaires exotiques nouvelles. *Cryptogamae Taitenses. Ann. Sci. Nat. Bot., sér. 3*, 10: 106–136.

- Petch T. 1921. Studies in entomogenous fungi. II. The genera of *Hypocrella* and *Aschersonia*. Ann. Roy. Bot. Gard. Peradeniya 7: 167–278.
- Petch T. 1925. Entomogenous fungi: additions and corrections. Trans. Br. Mycol. Soc. 10: 190–201.
- Qiu JZ, Ma HF, Wang YY, Guan X. 2009. Two *Aschersonia* species from Fujian new to China. Mycosystema 28(1): 60–63.

Two new genus records for Turkish mycota

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Abstract — The genera *Geopyxis* (Pyronemataceae) and *Asterophora* (Lyophyllaceae) are recorded from Turkey for the first time, based on collections of *Geopyxis carbonaria* and *Asterophora lycoperdoides*. Short descriptions and photographs of the taxa are provided.

Key words — Ascomycota, Basidiomycota, biodiversity, macrofungi

Introduction

Geopyxis carbonaria (Pyronemataceae) is an abundant post-fire discomycete in coniferous forests. This fleshy mushroom has a complex life cycle and is mycorrhizal on deep roots of members of the *Pinaceae*, and fruits only when the trees die (Vrålstad et al. 1998). Since it often fruits prolifically after wildfires, it has also been considered to be a possible indicator of imminent morel fruiting (Obst & Brown 2000).

Asterophora lycoperdoides (Lyophyllaceae) is a relatively rare basidiomycete that parasitizes other mushrooms in the family *Russulaceae*, especially *Russula nigricans* and *Russula densifolia*. It usually fruits after the host has blackened and begun to decay (Kuo 2006). The fungus generally reproduces asexually by brown powdery chlamydospores formed on the cap surface; its gills, which are often absent or deformed, produce sexual basidiospores only infrequently (Roody 2003).

According to checklists (Sesli & Denchev 2009) and recently published data (Solak et al. 2009, Kaya 2009), neither of the above taxa have previously been recorded from Turkey. The study aims to contribute to the macromycota of Turkey.

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Materials and methods

Specimens were collected from Artvin and Bingöl provinces in 2008. Fruit bodies were photographed and necessary ecological data were recorded in the field. In the laboratory, macroscopic and microscopic measurements were taken following standard mycological techniques and identified with the help of Breitenbach & Kränzlin (1984, 1991), Jordan (1995), and Vrålstad et al. (1998). The specimens are preserved in the fungarium of Yüzüncü Yıl University, Faculty of Art & Science, Department of Biology. Accession numbers contain the following abbreviations: U. = Uzun and D. = Demirel.

Taxonomy

Geopyxis carbonaria (Alb. & Schwein.) Sacc. 1889

MACROCHARACTERS — ASCOCARP 05–20 mm wide, at first sub-spherical, then cupped (usually goblet shaped), margins white, toothed or fringed, incurved to upturned, hymenial surface uniformly dull orange-brown to reddish brown, smooth; outer surface the same color, smooth or minutely whitish pruinose; **CONTEXT** brownish, thin and brittle, taste not significant, but odor very unpleasant when squashed in water; **STIPE** cylindrical, embedded in the substrate (FIG. 1a).

MICROCHARACTERS — ASCI 10–12 × 180–300 µm, 8-spored, cylindrical, hyaline (FIG. 1b); ASCOSPORES 11–17 × 7–9 µm, elliptical to slightly fusiform or oblong, smooth, thin-walled, hyaline and without droplets (FIG. 1c); **PARAPHYSES** cylindrical, septate.

SPECIMEN EXAMINED — Bingöl, Genç, coniferous forest, 38°44.723 N, 40°34.632 E, 1053 m, Yusuf Uzun, 13.05.2008, U.B622; 38°44.902 N, 40°34.148 E, 1050 m, Yusuf Uzun, 17.05.2008, U.B675.

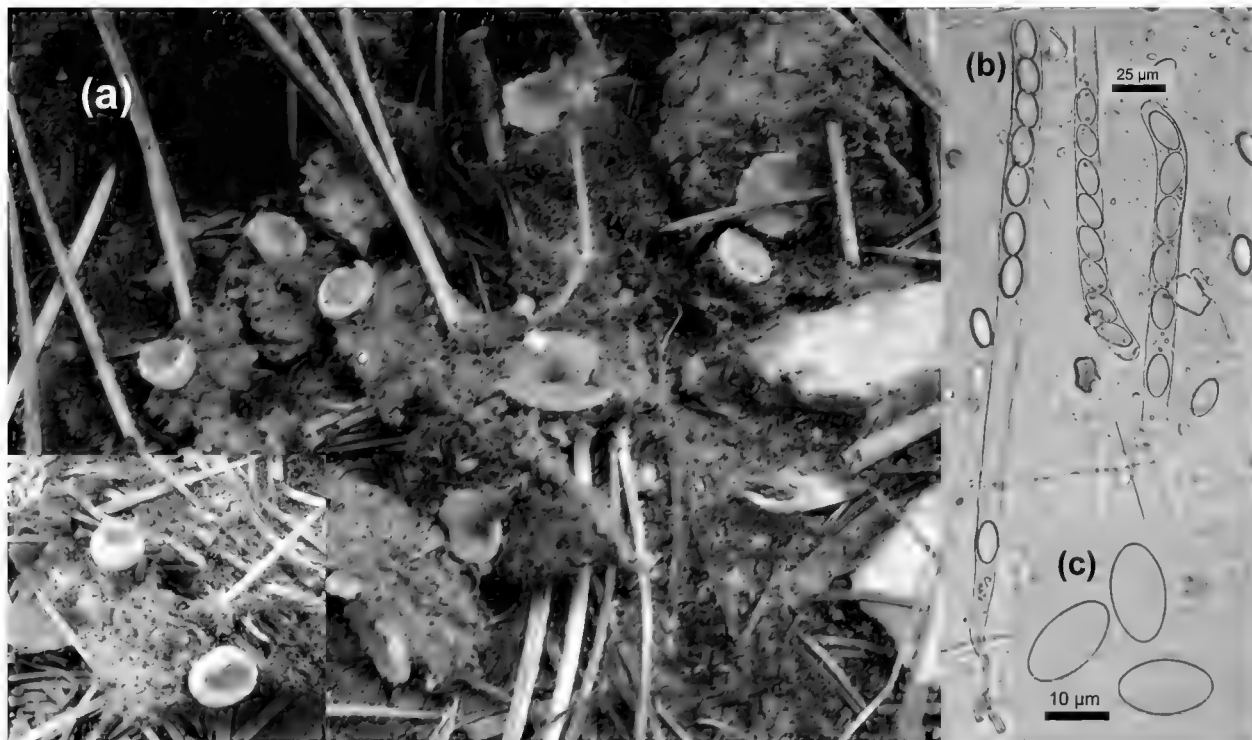


FIGURE 1. *Geopyxis carbonaria*, a. ascocarps, b. asci, c. ascospores.

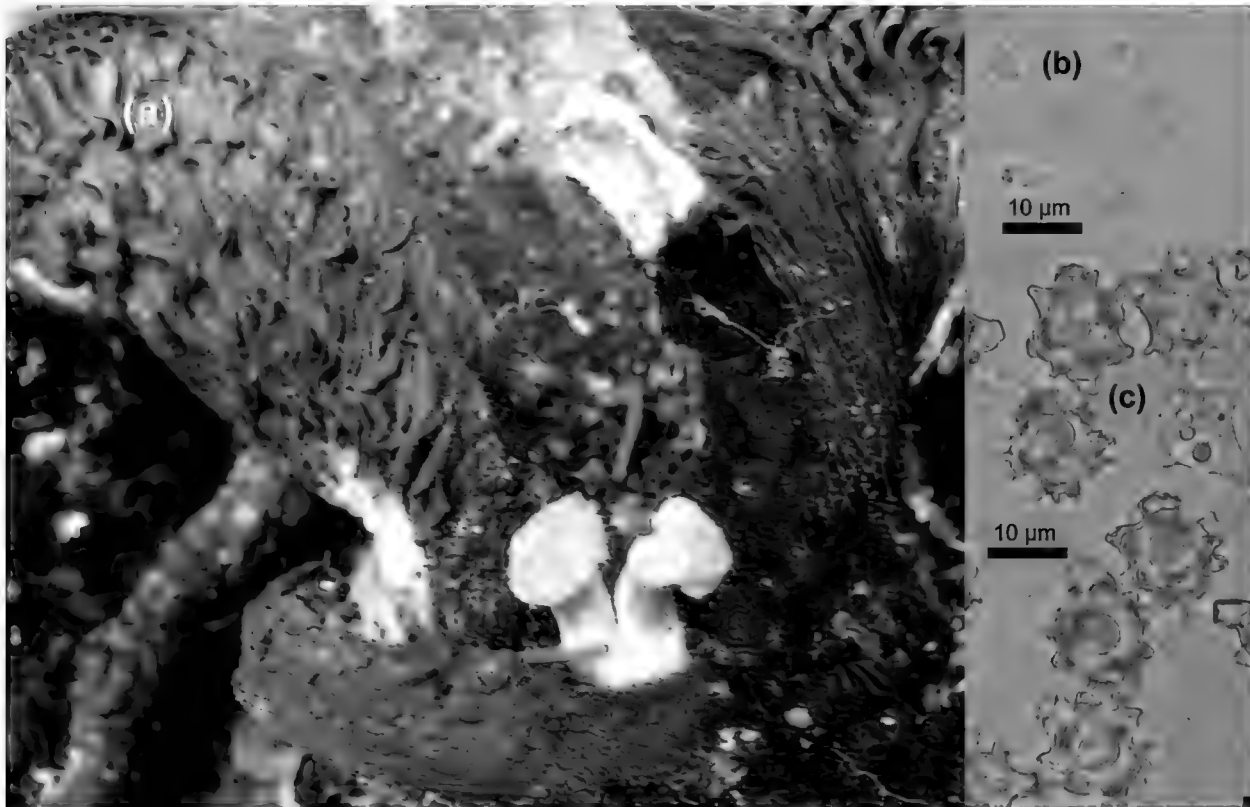


FIGURE 2. *Asterophora lycoperdoides*, a. basidiocarps, b. basidiospores, c. chlamydospores.

***Asterophora lycoperdoides* (Bull.) Ditmar 1809**

MACROCHARACTERS — PILEUS 10–25 mm across, hemispherical to convex, whitish and roughened or lumpy when young, brownish and powdery when mature, margin long inrolled; CONTEXT whitish; ODOR farinaceous; LAMELLAE whitish to grayish, usually poorly formed and vein-like; STIPE 10–25 × 3–7 mm, cylindrical, usually bent, hollow in age, smooth and whitish when young, cottony and brownish when mature (FIG. 2a).

MICROCHARACTERS — BASIDIOSPORES 3.5–6 × 2–4 µm, elliptical, smooth (FIG. 2b), usually difficult to find; CHLAMYDOSPORES 13–19 × 11–18 µm, oval to subglobose, verrucose or spiny (FIG. 2c); CLAMP CONNECTIONS present.

SPECIMEN EXAMINED — Artvin, Şavşat, Karagöl National Park, in coniferous forest, on old *Russula nigricans*, 41°18.612 N, 42°29.214 E, 1676 m, Kenan Demirel, 31.08.2008, D.5070–5071.

Discussion

Recent species lists of Turkish macromycota by Sesli & Denchev (2009), Solak et al. (2009), and Kaya (2009) cite 17 species representing 9 genera (i.e., *Aleuria*, *Ciliaria*, *Flavoscypha*, *Geopora*, *Humaria*, *Melastiza*, *Otidea*, *Scutellinia*, *Tarzetta*) in the *Pyronemataceae* and 17 species representing 5 genera (i.e., *Hypsizygus*, *Lyophyllum*, *Ossicaulis*, *Tephrocycbe*, *Calocybe*) in the *Lyophyllaceae* from Turkey.

Perry et al. (2007) observe that 75 genera and 500 species in *Pyronemataceae* have been recorded worldwide, and Bisby et al. (2009) include 9 genera and 73 species in the *Lyophyllaceae*. In view of these numbers and the macrofungal diversity estimates of Mueller et al. (2007) regarding the plant/macrofungus ratios of temperate regions, there is still much to be done to determine the overall distribution of these families in Turkey. Our study significantly contributes two additional species in two previously unrecorded genera to the known Turkish mycobiota.

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Literature cited

- Bisby FA, Roskov YR, Orrell TM, Nicolson D, Paglinawan LE, Bailly N, Kirk PM, Bourgoin T, Baillargeon G. 2009. Species 2000 & ITIS Catalogue of Life: 2009 Annual Checklist [<http://www.catalogueoflife.org/annual-checklist/2009/>].
- Breitenbach J, Kränzlin F. 1984, 1991. Fungi of Switzerland, vols. 1, 3 Lucerne, Verlag Mykologia.
- Jordan M. 1995. The encyclopedia of fungi of Britain and Europe. Devon, David & Charles Book Co.
- Kaya A. 2009. Macromycetes of Kahramanmaraş Province (Turkey). Mycotaxon 108: 31–34.
- Kuo M. 2006, October *Asterophora lycoperdoides*. Retrieved from the MushroomExpert.Com [http://www.mushroomexpert.com/asterophora_lycoperdoides.html].
- Mueller G M, Schmit JP, Leacock PR, Buyck B, Cifuentes J, Desjardin DE, Halling RE, Hjortstam K, Iturriaga T, Larsson KH, Lodge DJ, May TW, Minter D, Rajchenberg M, Redhead SA, Ryvar den L, Trappe JM, Watling R, Wu Qiuxin. 2007. Global diversity and distribution of macrofungi. Biodivers Conserv 16: 37–48.
- Obst J, Brown W. 2000. Feasibility of a morel mushroom harvest in the Northwest Territories. Yellowknife, NT, Canada, Artic Ecology and Development Consulting and Deton'cho Corporation.
- Perry BA, Hansen K., Pfister DH. 2007. A phylogenetic overview of the family *Pyronemataceae* (*Ascomycota*, *Pezizales*). Mycological Research 111: 549–571.
- Roody WC. 2003. Mushrooms of West Virginia and the Central Appalachians. Kentucky, The University Press of Kentucky.
- Sesli E, Denchev CM. (2009). Checklists of the myxomycetes, larger ascomycetes, and larger basidiomycetes in Turkey. Mycotaxon 106 [2008]: 65–67 + online version: 1–102 (<http://www.mycotaxon.com/resources/checklists/sesli-v106-checklist.pdf>).
- Solak MH, Allı H, Işıloğlu M, Kalmış E. 2009. Some new records of *Inocybe* (Fr.) Fr. from Turkey. Turk J Bot 33: 65–69.
- Vrålstad T, Holst-Jensen A, Schumacher T. 1998. The post-fire discomycete *Geopyxis carbonaria* (*Ascomycota*) is a biotrophic root associate with Norway spruce (*Picea abies*) in nature. Molecular Ecology 7: 609–616.

Notes on *Hydnochaete* (*Hymenochaetales*) with a seta-less new species discovered in China

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Abstract — *Hydnochaete asetosa* is described here as a new species from tropical China. It is distinguished from all other species by the absence of hymenial setae and the presence of clavate cystidia and oblong ellipsoid basidiospores. An annotated identification key is provided for the ten species thus far accepted in *Hydnochaete*.

Key words — *Hymenochaetaceae*, taxonomy, wood-inhabiting fungi

Introduction

The genus *Hydnochaete* was established by Bresadola (1896), revised systematically by Ryvarden (1982), and later studied by various authors (Parmasto 1995, Valenzuela et al. 1996, Parmasto 2005, Dai & Niemelä 2006, Yuan et al. 2006). The genus is well characterized by dark, reddish or yellowish brown basidiocarps, hydroid hymenophore, presence of hymenial setae, a monomitic to dimitic hyphal structure with simple septa on generative hyphae, and hyaline, thin-walled basidiospores. Most members of the genus occur in warm temperate, subtropical, and tropical forests (Ryvarden 1982, pers. obs.). The recent discovery of one *Hydnochaete* species with a few hymenial setae from Taiwan (Parmasto & Wu 2005) suggests that setae are probably pleomorphic in the genus.

As a result of nuclear rDNA sequence analysis of a limited sampling around *Hymenochaete* Lév. species that support *Hydnochaete duportii*, *H. japonica*, *Cyclomyces* Kunze ex Fr., and *Stipitochaete* Ryvarden clustering with *Hymenochaete* species, Wagner & Fischer (2002) transferred the two *Hydnochaete* species to *Hymenochaete*. These recombinations have been challenged, however, by a more recent rDNA phylogeny by Larsson et al. (2006). This analysis, which included a much larger taxon sampling in the

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hymenochaetoid clade, placed *Hymenochaete duportii*, *Hydnochaete japonica*, and *Hydnochaete olivacea* in different, well-supported clades. A robust phylogeny of *Hymenochaete*, *Hydnochaete*, *Cyclomyces*, *Stipitochaete*, *Pseudochaete*, and related fungi is still required for a reclassification of these fungi; nomenclaturally speaking, however, the oldest generic name, *Cyclomyces*, has priority if they are shown to be monophyletic at the genus level. Until then, we keep *Hydnochaete* as a morphological genus for practical purposes.

Among collections from a recent survey of wood-inhabiting fungi in tropical forests of Hainan, southern China, two specimens showed typical *Hydnochaete* characters such as golden yellowish brown basidiocarps, hydroid hymenophore, and a dimitic hyphal system with simple septate generative hyphae but no hymenial setae were found. The absence of setae combined with other morphological differences when compared to other *Hydnochaete* species lead us to propose a new species for these collections.

Materials and methods

The studied specimens were deposited in herbaria as cited below. Sections were studied at magnification up to x1000 by using a Nikon Eclipse E80i microscope and phase contrast illumination following guidelines set forth by Cui et al. (2009). Drawings were made with the aid of a drawing tube. Microscopic features, measurements, and drawings were made from slide preparations stained with Cotton Blue and Melzer's reagent. Spores were measured from sections cut from the tubes; in presenting spore size data, the 5% of the measurements excluded from each end of the range are shown in parentheses. Abbreviations include IKI (Melzer's reagent, with IKI- = inamyloid), KOH (5% potassium hydroxide), and CB (Cotton Blue; CB+ = cyanophilous; CB- = acyanophilous). Additional abbreviations include L (mean spore length; arithmetic average of all spores), W (mean spore width; arithmetic average of all spores), Q (variation in the L/W ratios between the specimens studied), and n (number of spores measured from given number of specimens). Special color terms follow Petersen (1996).

Description

Hydnochaete asetosa Y.C. Dai, sp. nov.

FIG. 1

MYCOBANK MB 516032

Carpophorum annuum, effuso-reflexum vel pileatum, hydnaceum; dentes usque ad 2 mm longi, 3–4 per mm. Systema hypharum monomiticum, hyphae generatoriae septatae, efibulatae; sporae oblonge-ellipsoideae, hyalinae, IKI-, CB-, 5–6 × 2.8–3.3 µm.

TYPE. — China. Hainan Prov., Changjiang County, Bawangling Nature Reserve, Dongsi, alt 1200 m, on dead tree of *Cyclobalanopsis* (Fagaceae), 8.V.2009 Dai 10756 (holotype in BJFC, isotype in IFP).

ETYMOLOGY — *asetosa* (Lat.) refers to the absence of setae.

FRUITBODY — Annual, pileate to effused-reflexed, often imbricate, coriaceous and without odour or taste when fresh, becoming brittle or rigid when dry. Pilei conchate, usually confluent, imbricate, projecting up to 2 cm, 5 cm wide and 2.5 mm thick at base; margin sharp. Upper surface of pilei dark brown to black when fresh, tomentose to hirsute with narrow concentric zones. Hymenophore hydroid, buff to pale yellow when fresh, becoming cinnamon-buff to honey-yellow up on drying; aculei clavate to subulate, terete or flattened, mostly solitary, rarely confluent, occasionally furcate, 3–4 per mm and up to 2 mm long. Context rust brown, hard corky, up to 0.5 mm thick, distinctly duplex, lower part dense, separated from upper part by one black line, upper part more or less tomentum.

HYPHAL STRUCTURE — Hyphal system monomitic; generative hyphae without clamp connections; tissue darkening but unchanged in KOH.

CONTEXT — Generative hyphae hyaline to golden yellow, thin- to distinctly thick-walled with a wide lumen, rarely branched, regularly arranged, 2–5 μm in diam. Hyphae in the dark line strongly agglutinate, dark brown, strongly interwoven. Hyphae in upper layer context (tomentum) golden yellow, distinctly thick-walled with a wide lumen, frequently simple septate, straight, unbranched, 2.5–4 μm in diam.

ACULEI — Tramal hyphae hyaline to yellowish brown, thin- to thick-walled, occasionally branched, flexuous, interwoven, some bearing yellowish crystals, 2–4.5 μm in diam. Setae absent. Cystidia abundant, basically clavate, sometimes fusiform, hyaline, thin- to slightly thick-walled, usually with an apical yellowish crystal, 40–57 \times 5–6 μm ; fusiform cystidioles occasionally present. Basidia clavate, with four sterigmata and a simple septum at the base, 13–19 \times 4–5 μm ; basidioles in shape similar to basidia, but slightly smaller. Hyphae at dissepiment edge sometime encrusted with yellowish crystals, cystidia alike.

SPORES — Basidiospores oblong ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, (4.7–)5–6(–6.7) \times (2.7–)2.8–3.3(–3.7) μm , L = 5.53 μm , W = 3.07 μm , Q = 1.77–1.84 μm (n = 60/2).

ADDITIONAL SPECIMEN (PARATYPE) EXAMINED — China. Hainan Prov., Changjiang County, Bawangling Nature Reserve, alt. 1200 m, on fallen trunk of *Cyclobalanopsis*, 8.V.2009 Cui 6382 (paratype in BJFC).

REMARKS — *Hydnochaete asetosa* is characterized by oblong ellipsoid basidiospores, clavate cystidia, and the absence of hymenial setae. Its basidiospores are the widest of all among *Hydnochaete* species, thus readily distinguishing it from other species in the genus that lack setae and possess clavate cystidia. The identification key to the ten accepted taxa below is based on specimen studies and literature data.

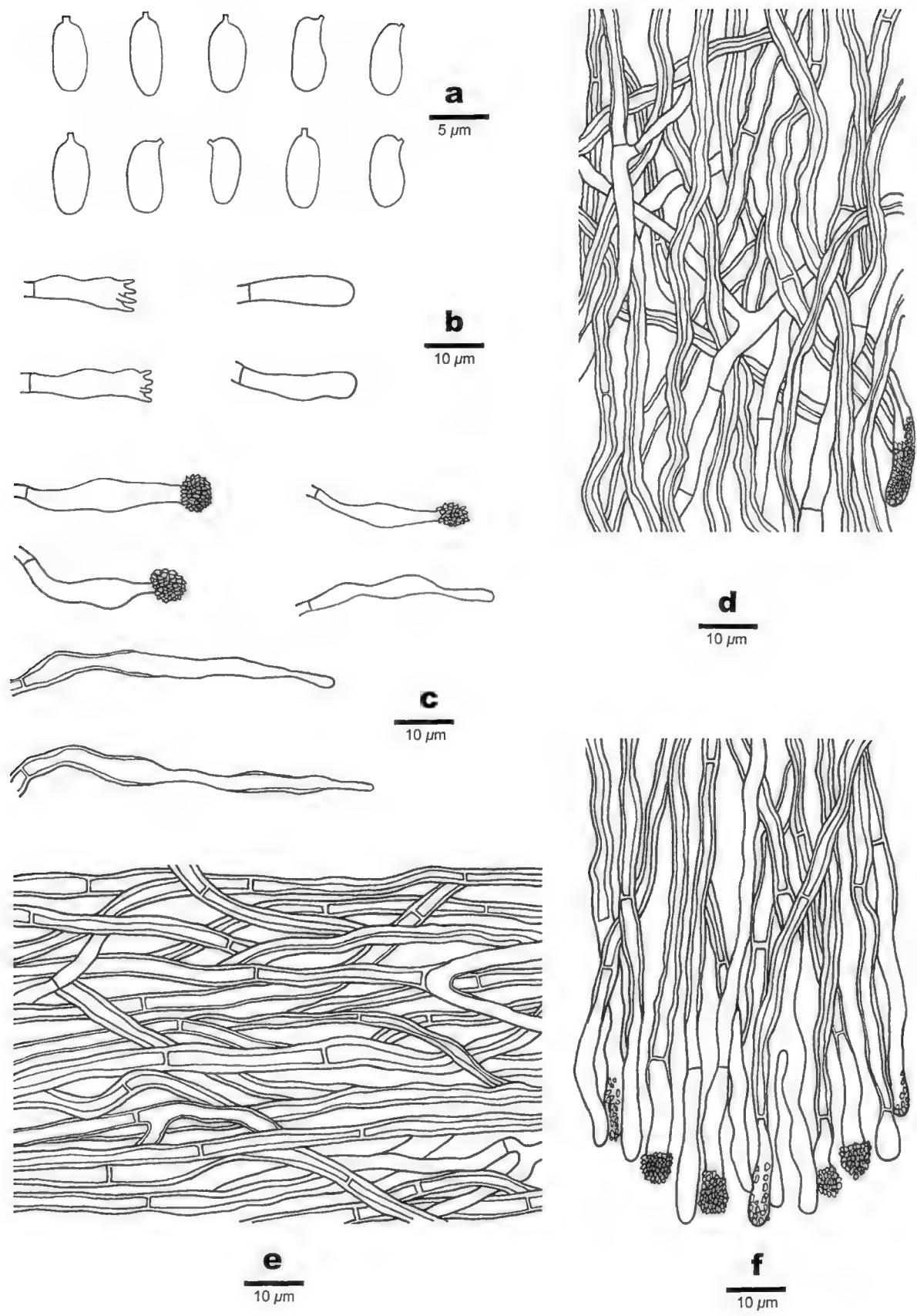


FIG. 1. Microscopic structures of *Hydnochaete asetosa* (drawn from the holotype).
—a: Basidiospores. —b: Basidia and basidioles. —c: Cystidia. —d: Hyphae from aculei.
—e: Hyphae from context. —f: Hyphae from dissepiment edge.

Key to accepted species of *Hydnochaete*

1. Setae absent or extremely rare 2
1. Setae present and abundant 3
2. Cystidia abundant
(spores oblong ellipsoid, $5-6 \times 2.8-3.3 \mu\text{m}$; setae always absent) *H. asetosa*
- 2 Cystidia absent
(Parmasto & Wu 2005: spores narrowly cylindric, $4.2-5.5 \times 1.4-1.8 \mu\text{m}$;
setae occasionally present but rare, $25-40 \times 4-6 \mu\text{m}$)
..... *H. paucisetigera* Parmasto & Sheng H. Wu
3. Spores $< 1.5 \mu\text{m}$ in width 4
3. Spores $> 1.5 \mu\text{m}$ in width 5
4. Context homogeneous; setae $> 8 \mu\text{m}$ in width
(Valenzuela et al. 1996: setae $50-150 \times 8-16 \mu\text{m}$; spores $4-5.6 \times 1-1.5 \mu\text{m}$)
..... *H. olivacea* (Schwein.) Banker
4. Context duplex; setae $< 8 \mu\text{m}$ in width
(Dai 5124: setae $32-65 \times 5-6 \mu\text{m}$; spores $4.6-5.2 \times 1.2-1.4 \mu\text{m}$)
..... *H. tabacina* (Berk. & M.A. Curtis ex Fr.) Ryvarden
5. Hyphal system monomitic, dichrohyphae present
(Valenzuela et al. 1996: setae $64-96 \times 6.4-10.2 \mu\text{m}$; spores $3.2-4.8 \times 1.6-2 \mu\text{m}$)
..... *H. resupinata* (Sw.) Ryvarden
5. Hyphal system dimitic, dichrohyphae absent6
6. Hymenophore hydroid to semi-lamellate; setae apically encrusted
(Dai & Niemelä 2006: setae $50-110 \times 7-20 \mu\text{m}$; spores $4.5-5.5 \times 1.5-1.9 \mu\text{m}$)
.....*H. tabacinoides* (Yasuda) Imazeki
6. Hymenophore hydroid or papillate; apices of setae smooth7
7. Hymenophore papillate to hydroid, spines 3–5/mm
(Ryvarden 1982: setae $35-70 \times 7-15 \mu\text{m}$; spores: $3-4 \times 1.5-2 \mu\text{m}$)
.....*H. peroxydata* (Berk. ex Cooke) Dennis
7. Hymenophore hydroid, spines 1–3/mm8
8. Basidiocarps pileate, context distinctly duplex, spines 1–2 mm long
(Ryvarden 1982: setae $35-150 \times 6-9 \mu\text{m}$; spores: $4-5 \times 1.5-2 \mu\text{m}$)
.....*H. saepiaria* (Lloyd) Ryvarden
8. Basidiocarps resupinate, context homogeneous, spines ≤ 0.8 mm long9
9. Black line present next to substrate, aculei sharp
(Dai & Niemelä 2006: setae $40-120 \times 7-14 \mu\text{m}$; spores: $4.5-5 \times 1.5-2 \mu\text{m}$)
.....*H. duportii* Pat.
9. Black line absent, aculei blunt
(HMAS 35618: setae $30-68 \times 5.8-8 \mu\text{m}$; spores: $3.9-4.5 \times 1.6-2 \mu\text{m}$)*H. japonica* Lloyd

OTHER SPECIMENS EXAMINED. — *Hydnochaete duportii*. China. Guangxi Auto. Reg., Donglan County, on fallen angiosperm trunk, 20.I.1958 Xu 811 (HMAS 35617).
— *H. japonica*. China. Guangxi Auto. Reg., on fallen angiosperm trunk, 14.IX.1958

Liang 1626 (HMAS 35618). Fujian Prov., on dead angiosperm tree, 17.XI.1955 Yu (HMAS 34810). — *H. olivacea*. Canada, Quebec Prov., Gatineau Park, Pinks Lake., on *Quercus*, 11.VII.1979 Binyamini 672 (H). USA. West Virginia, on dead limbs of *Quercus*, 30.VII.1938 Bonar (HMAS 49250). — *H. paucisetigera*. China. Taiwan, Nanton, Huisun Forest Station, on fallen angiosperm branch, 12.VII.1997 Wu 971212 (TNM F10074, type). — *H. tabacina*. China. Beijing, Tanzhesi, on fallen trunk of *Quercus*, 25.IX.2003 Dai 5124 (IFP). — *H. tabacinoides*. China. Hunan Prov., Liuyang County, Daweishan Nature Reserve, on fallen trunk of *Camellia*, 21.XII.2000 Dai 3267 (IFP).

As mentioned by Ryvarden (1982), *Hydnochaete japonica* and *H. duportii* are very similar, and their differences are mostly in macromorphology. Ito (1955) stated that spores of *H. japonica* are hyaline and thin-walled, globose, 3.5 μm in diam. Of the three specimens of *H. japonica* from China studied, the few spores found from specimen HMAS 34810 were cylindric, hyaline, thin-walled, smooth, $3.9\text{--}4.5 \times 1.6\text{--}2 \mu\text{m}$. According to our study, *H. japonica* and *H. duportii* basidiospores are very similar, but *H. duportii* has longer, sharp spines while those in *H. japonica* are shorter and blunt. Wagner & Fischer (2002) cited similar nLSU rDNA sequences for *H. japonica* and *H. duportii*, but the subsequent phylogenetic analysis of *Hymenochaetales* by Larsson et al. (2006) supports slight differences between *Hydnochaete japonica* and *H. duportii*. We keep the two species independent for the time being, and more fresh materials are needed to confirm the situation.

We retain *Hydnochaete* as a morphological genus although the Larsson et al. (2006) phylogenetic placement of *H. olivacea* into a clade separate from *H. japonica* and *H. duportii* suggests that the genus as currently delimited is polyphyletic. Subdivision of *Hydnochaete* is anticipated once a phylogeny is generated that includes all ten *Hydnochaete* species.

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Literature cited

- Bresadola J. 1896. *Fungi Brasiliensis lecti a al. Dr. Alfredo Möller*. Hedwigia 35: 276–295.
- Cui BK, Dai YC, Li BD. 2009. Notes on the genus *Rigidoporus* (*Basidiomycota*, *Aphylllophorales*) in China. Nova Hedwigia 88: 189–197.
- Dai YC, Niemelä T. 2006. *Hymenochaetaceae* in China: hydroid, stereoid and annual poroid genera, plus additions to *Phellinus*. Acta Botanica Fennica 179: 1–78.
- Ito S. 1955. Mycological flora of Japan 2. *Basidiomycetes* 4. *Auriculariales*, *Tremellales*, *Dacrymycetales*, *Aphylllophorales* (*Polyporales*). Yokendo, Tokyo. 450 pp. (in Japanese).
- Larsson K-H, Parmasto E, Fischer M, Langer E, Nakasone KK, Redhead SA. 2006. *Hymenochaetales*: a molecular phylogeny for the hymenochaetoid clade. Mycologia 98: 926–936.

- Parmasto E. 1995. The genus *Hymenochaete* (*Hymenomycetes*): Infrageneric classification and satellite genera. *Documents Mycologiques* 100: 305–315.
- Parmasto E. 2005. New data on rare species of *Hydnochaete* and *Hymenochaete* (*Hymenochaetales*). *Mycotaxon* 91: 137–163.
- Parmasto E, Wu SH. 2005. *Hydnochaete paucisetigera*, a new species of *Hymenochaetales*. *Mycotaxon* 91: 461–463.
- Petersen JH. 1996. Farvekort. The Danish Mycological Society's colour-chart. Foreningen til Svampekundskabens Fremme, Greve. 6 pp.
- Ryvarden L. 1982. The genus *Hydnochaete* Bres. (*Hymenochaetaceae*). *Mycotaxon* 15: 425–447.
- Valenzuela R, Nava R, Cifuentes J. 1996. La familia *Hymenochaetaceae* en México 1. El género *Hydnochaete* Bres. *Polib Técnica* 1: 7–15.
- Wagner T, Fischer M. 2002. Classification and phylogenetic relationships of *Hymenochaete* and allied genera of the *Hymenochaetales*, inferred from rDNA sequence data and nuclear behaviour of vegetative mycelium. *Mycological Progress* 1: 93–104.
- Yuan HS, Sun XQ, Liu Y. 2006. *Hydnochaete tabacina* (*Hymenochaetaceae*, *Aphyllophorales*), a new record in China. *Forest Research* 19: 669–671.

Some parmelioid lichens new to Turkey and Asia

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Abstract — Five parmelioid species of lichenized fungi — *Myelochroa aurulenta*, *Parmelinopsis minarum*, *Parmotrema hypoleucinum*, *Parmotrema reticulatum* and *Xanthoparmelia verrucigera* — are reported as new to Turkey. *Parmotrema hypoleucinum* and *Xanthoparmelia verrucigera* are also new to Asia while *Parmelinopsis minarum* and *Parmotrema reticulatum* are new to the Middle East. Geographic distribution, substrate, chemistry, and comparisons with morphologically similar taxa are presented.

Keywords — Ardahan, Ascomycota, biodiversity

Introduction

In comparison with other countries, prior to the present decade few lichen studies have been conducted in Turkey, so that the lichen biota of Turkey remains poorly known. Recently, however, many new lichen taxa have been recorded for Turkey (Aptroot & Yazici 2009, Candan & Özdemir Türk 2008, Etayo & Yazici 2009, Yazici et al. 2008a,b, Yazici & Aptroot 2008). Five lichenized fungi new to Turkey and Asia are described below.

Material and methods

The present report is based on collections from Ardahan region made between 15–20 August 2008. Air dried samples were observed and studied with a Nikon SMZ1500 stereomicroscope and a Nikon Eclipse 80i light microscope using standard identification methods for lichenized fungi. The nomenclature and genera and species concepts follow Hale (1974), Elix & Hale (1987), Elix (1994),

Brodo et al. (2001), Louwhoff & Elix (1999, 2002), Elix & Wardlaw (2000), Blanco et al. (2004, 2005), Divakar & Upreti (2005), Marcelli & Canêz (2008). Natural chemical products have been identified by Standard TLC and HPLC procedures. Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Karadeniz Technical University, Trabzon, Turkey (KTUB).

Species

Myelochroa aurulenta (Tuck.) Elix & Hale, Mycotaxon 29: 240. 1987.

SPECIMEN EXAMINED: Ardahan, Posof, center (Control Tower Forests), 41°31'36.83"N, 42°44'03.48"E, on moss and calcareous rock, 1920m, 20.08.2008, KTUB 2021.

Thallus moderately adnate, to 12 cm wide. Lobes sublinear to subirregular, 2–4 mm wide, or rounded, contiguous or imbricate, older lobes centrally contorted, sublinear, subdichotomously to irregularly branched, 2–4 mm wide; margins entire or crenate, ciliate; cilia, simple, short, sparse to \pm dense, mostly concentrated in lobe axils. Upper surface pale grey to grey-green, sorediate to pustulate-sorediate, \pm maculate, \pm pruinose, smooth, becoming rugulose centrally with distinct, cracked areas exposing the medulla; soralia laminal, \pm dense, some soralia with granular soredia, coalescing into large, subcapitate clumps. Medulla whitish to pale yellow, sometimes \pm sulphur-yellow. Lower surface black with a brown marginal zone (1–5 mm wide), smooth to rugulose, \pm densely rhizinate; rhizines black, simple to sparsely furcate or squarrose branched. Apothecia and pycnidia not seen. Cortex K+ yellow, medulla K–, C–, KC–, P–; containing atronorin acid (minor), zeorin (major), leucotylic acid (major), secalononic acid A (minor).

Myelochroa aurulenta is a pantemperate to pantropical or Mediterranean lichen species, occurring on bark, walls in small urban areas, rarely on inclined calcareous rocks along roadsides and also in disturbed vegetations and gardens at altitudes of 700–1700 m.

COLLECTION SITE — In the collection area dominate microclimatic conditions with mild and rainy winters and hot summers. Mean annual temperature is 6.8°C. Mean annual rainfall is 600 mm. The collection site was more or less well lit and open with a stream and *Pinus* trees dominant in the vicinity.

KNOWN DISTRIBUTION: Africa, Asia (China, Georgia, India, Korea, Japan, Thailand), Australia, North America and the Pacific [the Hawaiian Islands, Papua New Guinea]. New to Turkey.

REMARKS—*Myelochroa aurulenta* is similar to *Hypotrachyna endochlora* (Leight.) Hale and *Myelochroa supraflava* Canêz & Marcelli. All three species have pigmented medulla and pustulate-sorediate upper surface, but *H. endochlora* has richly dichotomously branched rhizines and is distinguished by the absence of marginal cilia. *M. aurulenta* has sublinear to subirregular or rounded lobes, simple to barely forked or squarrose rhizinae, and distinct,

cracked areas exposing white to yellow patchy medulla. *Myelochroa supraflava* is distinguished by the upper medulla being yellow throughout and in having mainly simple rhizines.

Parmelinopsis minarum (Vain.) Elix & Hale, Mycotaxon 29: 243. 1987.

SPECIMEN EXAMINED: Ardahan, Posof, Kurşunçavuş village, near the stream, 41°31'37.76"N, 42°37'16.40"E, on *Pinus* sp., 1790 m, 15 August 2008, KTUB 2019.

Thallus adnate, to 2–7 cm wide; lobes contiguous, sublinear-elongate, ± dichotomously branched, 1–3 mm wide; cilia irregularly dispersed, mostly simple, to 0.7 mm long. Upper surface whitish to pale greenish-grey, flat to convex, shiny, emaculate, smooth, without soredia and pustules; isidia mostly branched, cylindrical, to 0.5 mm tall, erect, eciliate, dense. Medulla white. Lower surface black; rhizines shiny, simple or sparingly furcate, moderately dense, black. Apothecia very rare; thalline exciple isidiate. Cortex K+ yellow; medulla P–, K–, C+ pink, KC+ red. Ascospores 12–17 × 8–10 µm. Pycnidia rare. Conidia cylindrical, 3–4 × 0.5 µm, containing atranorin acid (minor), chloroatranorin acid (minor), gyrophoric acid (major), umbilicic acid (minor).

Parmelinopsis minarum grows on bark and rock in moist forests. It is a cosmopolitan species that has been reported from all continents except Antarctica. The species grows on bark of different trees and rocks in moist forests covering Mediterranean zone around the World

COLLECTION SITE – The Turkish specimen of *P. minarum* has been found in more or less well-lit and open locality covered with a stream and occasional *Corylus*, *Populus*, *Salix*, *Carpinus* and *Picea orientalis*. Microclimatic conditions with mild and rainy winters and hot summers dominate in the study area. Mean annual temperature is 6.8°C. Mean annual rainfall is 600 mm.

KNOWN DISTRIBUTION: Europe, Africa, Asia, Australia, North America, South America, New Zealand and Papua New Guinea. New to Turkey and Middle East.

REMARKS—*Parmelinopsis minarum* is very similar to *P. horrescens* (Taylor) Elix & Hale. In *P. minarum* the isidia are cylindrical and ± branched and very rarely ciliate at the apices, whereas the isidia in *P. horrescens* are typically coralloid-lobulate and apically ciliate. Moreover, *P. horrescens* produces 3-methoxy-2,4-di-O-methygyrophoric and 2,4-di-O-methylgyrophoric acids as the major medullary substances (C–), while *P. minarum* contains gyrophoric acid (C+ pink) rather than gyrophoric acid.

Parmotrema hypoleucinum (J. Steiner) Hale, Phytologia 28(4): 336. 1974.

SPECIMEN EXAMINED: Ardahan, Posof, center (Control Tower Forests), near the stream, 41°31'36.83"N, 42°44'03.48"E, on *Pinus* sp., 1918 m, 20.08.2008, KTUB 2022.

Thallus pale greenish-gray to white, with vague to distinct white maculae on the upper surface; lower side dark-brown sometimes pale with a broad bare white zone at the margins, black in the center; lobes dull, suberect upper cortex

continuous, 3–15 mm wide and often curled back showing ivory-white patches; when maculate, the maculae not reticulately arranged but scattered. Soralia patchy, linear or round to diffuse, occasionally pustulate or submarginal. Cilia well developed, long, quite sparse at the lobe apices but more abundant in lobe axils. Medulla white (sometimes with patches of orange-red skyrin near lower cortex; in decaying plants salazinic acid may cause red staining). Apothecia rare. Cortex K+ yellow; medulla P+ orange, K+ yellow to orange, KC–, C–, I+ blue, containing atranorin acid (minor), stictic acid (major), cryptostictic acid (minor), menegazziaic acid (minor), norstictic acid (minor).

Parmotrema hypoleucinum is a mediterranean-atlantic lichen, found on twigs of trees and shrubs in undisturbed Mediterranean maquis along the coast.

COLLECTION SITE – See *Myelochroa aurulenta* above.

KNOWN DISTRIBUTION: Western and southern Europe, North America. New to Turkey and Asia.

REMARKS—*Parmotrema hypoleucinum* is morphologically identical to *P. hypotropum* (Nyl.) Hale, but *P. hypotropum* is distinguished by the presence of norstictic and connorstictic acids and colour reactions of medulla (P+deep yellow, K+ yellow turning red and I–). *Parmotrema hypoleucinum* differs from the more common *P. perlatum* (Huds.) M. Choisy in being sparsely ciliate, white at under site of lobe margins and containing minor amounts of norstictic acid.

Parmotrema reticulatum (Taylor) M. Choisy, Bull. mens. Soc. linn. Lyon 21: 148. 1952.

SPECIMEN EXAMINED: Ardahan, Posof, center (Control Tower Forests), 41°31'36.83"N, 42°44'03.48"E, on moss and *Pinus* sp., 1920m, 20.08.2008, KTUB 2017.

Thallus loosely adnate, coriaceous, up to 10–20 cm wide. Lobes ± imbricate along margins, subirregular to sublinear, ± rounded at apices; margins entire to irregularly-incised or laciniate-dissected, ciliate. Cilia slender, simple, up to 1 mm long, moderately dense to dense. Upper surface pale grey-green, effiguratly maculate, soon reticulately cracked, sorediate. Soralia marginal, linear or subcapitate at apices of laciniae which become subrevolute; soredia granular, occasionally spreading laminally. Medulla white. Lower surface black, centrally rhizinate, rhizines extending to lobe margins, or present a thin, brown, shiny, erhizinate marginal zone. Rhizines, black, simple or squarrosely-branched, soon forming dense clumps. Apothecia rare, submarginal, 3–5(–8) mm wide; thalline exciple entire or ± crenulate, sorediate; disc imperforate, or soon perforate, brown. Ascospores ellipsoid to subglobose 10–16.5 × 7.5–10 µm. Cortex K+ yellow, medulla K+ yellow than red, C–, P+ deep orange/red; containing atranorin acid (minor), salazinic acid (major), consalazinic acid (minor).

This is a mediterranean-atlantic to temperate lichen, widespread throughout the tropics and temperate areas. It occurs on bark of different trees, rarely on mossy siliceous rocks at altitudes of 780–2360 m.

COLLECTION SITE – See *Myelochroa aurulenta* above.

KNOWN DISTRIBUTION: Europe, Asia, Africa, Australia, North and South America. New to Turkey and Middle East

REMARKS—*Parmotrema reticulatum* resembles *P. cristiferum* (Taylor) Hale, but the marginal laciniae and cilia, the branched rhizines which extend to the lobe margin and the reticulately cracked upper cortex distinguish *P. reticulatum* from the later. *P. cristiferum* is eciliate and has simple rhizines and a bare marginal zone on the lower surface.

Xanthoparmelia verrucigera (Nyl.) Hale, Smithson. Contr. bot. 74: 220. 1990.

SPECIMEN EXAMINED: Ardahan, Posof, Kurşunçavuş village, near the stream, 41°31'37.76"N, 42°37'16.40"E, on siliceous rock, 1790 m, 15 August 2008, KTUB 2023.

Thallus up to 6 cm wide, saxicolous, foliose, adnate to tightly adnate; lobes contiguous, subirregular to sparingly imbricate, irregularly branched, upper surface yellow green, moderately to densely isidiate. Isidia simple, cylindrical or rarely sparsely branched and verrucose. Medulla white. Rhizines sparse to moderately dense, simple, black, concoloured with the lower surface of thallus. Cortex K–, C–, KC+ pale yellow, P–. Medulla K+ persistent yellow, C–, KC+ red, P+ orange. Apothecia and pycnidia not seen. Stictic (major), constictic (minor), lusitanic (minor) and verrucigeric (minor) acids present.

Xanthoparmelia verrucigera prefers siliceous rocks, but also occur on basic or ultrabasic substrata such as basalt or tuff.

COLLECTION SITE – See *Parmelinopsis minarum* above.

KNOWN DISTRIBUTION: Africa: Zimbabwe, Australia, Europe (France, Portugal, Romania, Spain, Hungary, Italy), Pacific Islands: Pascua, Rapa Nui, North America. New to Turkey and Asia.

REMARKS—Morphologically *X. verrucigera* resembles *X. subverrucigera* O. Blanco, A. Crespo & Elix and *X. conspersa* (Ach.) Hale, but *X. subverrucigera* has a brown lower surface (jet-black in the other two species). *X. conspersa* differs from *X. verrucigera* in the chemistry, since it contains stictic (major), constictic (submajor), cryptostictic (minor), norstictic (minor), connorstictic (trace), ± menegazziaic (trace) and ± hyposalazinic acids (trace) but lacks lusitanic and verrucigeric acids found in the later species. Molecular studies have shown that *X. conspersa* and *X. verrucigera* are not closely related (Blanco et al. 2004).

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Literature cited

- Aptroot A, Yazici K. 2009. *Opegrapha pauciexcipulata*, a new corticolous lichen from Turkey. Mycotaxon 108: 155–158.
- Blanco O, Crespo A, Elix JA, Hawksworth DL, Lumbsch HT. 2004. A molecular phylogeny of parmelioid lichens containing *Xanthoparmelia*-type lichenan (Ascomycota: Lecanorales). Taxon 53(4): 959–975.
- Blanco O, Crespo A, Elix JA. 2005. Two new species of *Xanthoparmelia* (Ascomycota: Parmeliaceae) from Spain. Lichenologist 37(2): 97–100.
- Brodo MI, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. 1st Edition. Yale Univ. Press, New Haven and London.
- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). Mycotaxon 105: 19–22.
- Divakar PK, Upreti DK. 2005. Parmelioid lichens in India. A revisionary study. India: Bishen Singh Mahendra Pal Singh, 488 p.
- Elix JA. 1994. *Myelochroa*. Flora of Australia 55: 66–67.
- Elix JA, Hale ME. 1987. *Canomaculina*, *Myelochroa*, *Parmelinella*, *Parmelinopsis* and *Parmotremopsis*, five new genera in the *Parmeliaceae* (lichenized Ascomycotina). Mycotaxon 29: 233–244.
- Elix JA, Wardlaw JH. 2000. Lusitanic acid, peristictic acid and verrucigeric acid. Three new β -orcinol depsidones from the lichens *Relicina sydneyensis* and *Xanthoparmelia verrucigera*. Australian J. Chem. 53: 815–818.
- Etayo J, Yazici K. 2009. *Microsphaeropsis caloplacae* sp. nov. on *Caloplaca persica* in Turkey. Mycotaxon 107: 297–302.
- Hale ME. 1974. New combinations in the lichen genus *Parmotrema* Massalongi. Phytologia 28: 334–339.
- Hale ME. 1990: A synopsis of the lichen genus *Xanthoparmelia* (Vainio) Hale (Ascomycotina, *Parmeliaceae*). Smithsonian Contributions to Botany 74: 1–250.
- Louwhoff SHJJ, Elix JA. 1999. *Parmotrema* and allied lichen genera in Papua New Guinea. Biblioth. Lichenol. 73: 1–152.
- Louwhoff SHJJ, Elix JA. 2002. *Hypotrachyna* (Parmeliaceae) and allied genera in Papua New Guinea. Biblioth. Lichenol. 81: 1–150.
- Marcelli MP, Canêz LS. 2008. Novelties on Southern Brazilian *Parmeliaceae*. Mycotaxon 105: 225–234.
- Yazici K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. Mycotaxon 105: 95–104.
- Yazici K, Aptroot A, Etayo J, Aslan A, Guttova A. 2008a. Lichens from the Batman, Mardin, Osmaniye, and Sivas regions of Turkey. Mycotaxon 103: 141–144.
- Yazici K, Elix JA, Aslan A. 2008b. *Xanthoparmelia pustulosa* (Parmeliaceae), a lichen new to Asia. Mycotaxon 104: 35–37.

***Entoloma festivum*, a new species in subgenus *Trichopilus* from the Netherlands**

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Abstract — A full description is given of *Entoloma festivum*, a new species in subgenus *Trichopilus*, from the Netherlands. It is distinguished by its brown, radially striate pileus with squamulose centre and the polished stipe.

Key words — *Entolomataceae*

Introduction

The genus *Entoloma* is the second largest genus of *Agaricales* (after *Cortinarius*) and monophyletic (Co-David et al. 2009). Although it is fairly well known, in particular from Europe (Noordeloos 1992, 2004), new species are continuously discovered. During an investigation of the nature reserve de Leemputten (loam pits) in Dorst, prov. Noord-Brabant, a remarkable little *Entoloma* species has been discovered in a grassy-mossy, rather exposed, place. Its morphological characters are so different from the known species that it is described here as new. The specific epithet *festivum* not only means handsome, but is also sounds festive, commemorating the hundredth anniversary of the Dutch Mycological Society in 2008, when it was first made public.

Taxonomic description

Entoloma festivum Noordel., Rommelaars & Gelderblom, spec. nov.

MYCOBANK MB 515481

FIGS. 1, PLATE 1.

NOTE — MYCOTAXON prepared this PDF with color plates for the author.
The original print version was published with halftone (grayscale) plates.

Habitus mycenoideus. Pileus 6–12 mm, acute conicus, hygrophanus, translucido-striatus, fuscobrunneus, fibrillosus, centro atrobrunneo, conspicue fibrilloso-furfuraceo; lamellae distantes, adnato-emarginatae, albae demum roseae brunneofimbriatae. Stipes 10–20 × 1–2 mm, fuscobrunneus, glaber, politus; sporae 8.5–10.5 × 5.5–7.5 µm, heterodiametricae, 5–8 angulatae; acies lamellarum steriles; cheilocystidia versiformia, clavata vel lageniformia vel tibiiformia, cum pigmento intracellularem; pileipellis ex hyphis inflatis trichodermium formantibus, elementae terminalis clavatae, ad 20 µm latae pigmento intracellularem instructae; fibulae praesentes. In pratis, aestate.

HOLOTYPE: L. Rommelaars, 17 VII 2004, Netherlands, Prov. Noord Brabant, Dorst Nature reserve (L).

ETYMOLOGY: *festivum* (Lat.) = handsome.

MACROCHARACTERS — **PILEUS** 6–12 mm, convex to applanate with small, pointed umbo or slightly depressed at centre, with straight margin, hygrophanous, translucently striate almost to centre, warm reddish brown with almost black centre, radially fibrillose-scurfy, particularly at centre. **LAMELLAE** L = up to 20, l = 1–3, distant, adnate-emarginate with decurrent tooth, white then pink with entire, concolorous or brown edge. **STIPE** 10–20 × 1–2 mm, reddish brown, apex pruinose, downwards glabrous, polished. **SMELL AND TASTE** not noted.

MICROCHARACTERS — **BASIDIOSPORES** 8.5–10.5 × 5.5–7.5 µm, Q = 1.3–1.6, heterodiametrical, 5–8 angled in side-view. Basidia 4-spored. **LAMELLA EDGE** sterile. **CHEILOCYSTIDIA** 18–43 × 6–13 µm, clavate to lageniform or tibiiform, often with brown, intracellular pigment. **HYMENOPHORAL TRAMA** regular, made up of medium-sized, cylindrical elements, 60–120 × 7–20 µm. Pileipellis a trichoderm of septate hyphae, 8–15 µm wide, with clavate terminal elements, 12–30 × 8–20 µm with abundant, brown, intracellular pigment. **BRILLIANT GRANULES** absent. **CLAMP-CONNECTIONS** present.

ECOLOGY AND DISTRIBUTION — In nutrient-poor, mossy grassland on sandy loamy soil. Only known from the type locality in the Netherlands

COMMENTS — *Entoloma festivum* is an attractive little species with its brown, strongly striate pileus with dark, scurfy centre, brown lamellae, and polished stipe. The distinctly capitate (in part) cheilocystidia remind of those found in *Entoloma* subgenus *Trichopilus*, but most species in this group differ by having a non- or weakly hygrophanous, opaque, non-translucent pileus (Noordeloos 2004). *Entoloma brunneoflocculosum* Arnolds & Noordel. is a somewhat similar species with a non-striate pileus, smaller spores, and fertile lamellar edge. The extralimital species from Tasmania, *Entoloma sepiaceovelutinum* G.M. Gates & Noordel., superficially resembles our species but differs strikingly by the much larger spores and large lageniform cheilocystidia (Gates & Noordeloos 2007). *Entoloma corneum* E. Horak from New Zealand is smaller, has a translucently striate pileus, less distinctly angled spores, and clampless basidia (Horak 2008).

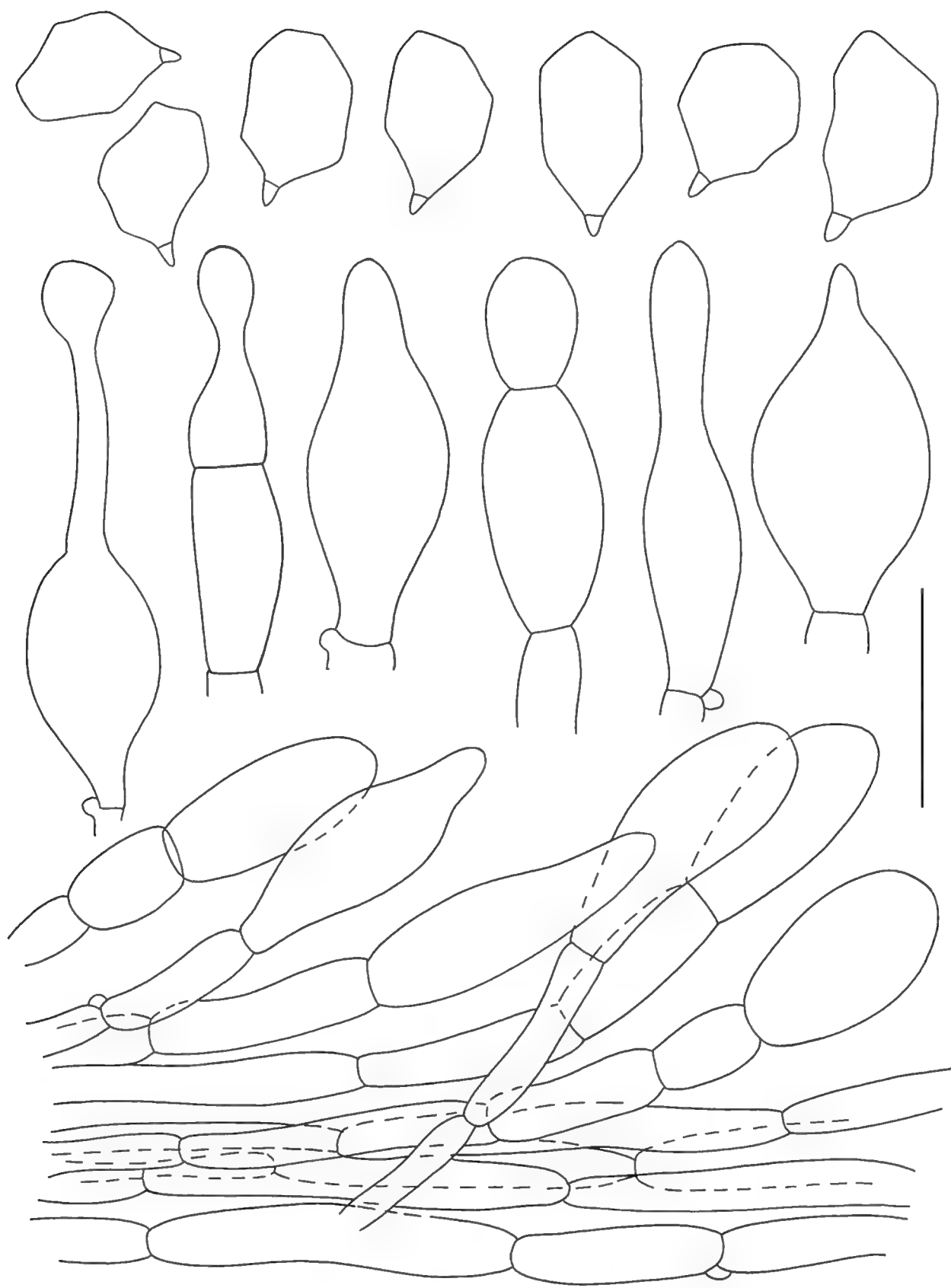


FIG. 1. *Entoloma festivum*. Spores, cheilocystidia, and pileipellis.
All figs from holotype. Bar = 10 μ m.



PLATE 1. *Entoloma festivum*. Basidiocarps in situ. (Photo Rommelaars)

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Literature cited

- Co-David DLV, Langeveld D, Noordeloos ME. 2009. The molecular phylogeny and spore evolution of *Entolomataceae*. *Persoonia* 23: 147–176.
- Gates GM, Noordeloos ME. 2007. Preliminary studies in the genus *Entoloma* in Tasmania – I. *Persoonia* 19: 157–226.
- Horak E. 2008. *Agaricales* of New Zealand 1: *Pluteaceae* – *Entolomataceae*. The fungi of New Zealand, vol. 5. Fungal Diversity Research Series, vol. 19. Fungal Diversity Press, Hong Kong.
- Noordeloos ME. 1992. *Entoloma* s.l. *Fungi Europaei*, vol. 5. Giovanna Biella, Italy.
- Noordeloos ME. 2004. *Entoloma* s.l. *Fungi Europaei*, vol. 5a. Edizione Candusso, Italy.

Nomenclature — Formal reports, proposals, and opinion

Abstract — Formal proposals to conserve or protect fungal names as well as proposals to amend the INTERNATIONAL CODE OF NOMENCLATURE of immediate interest to mycologists are now published concurrently in MYCOTAXON and TAXON. Conservation proposals include Prop. 1918 (to conserve the name *Dermatocarpon bucekii* against *Placidium steineri*), Prop. 1919 (to conserve the name *Lactarius* with a conserved type), Prop. 1926 (to conserve the name *Cladia* against *Heterodea*, and Prop. 1927 (to conserve the name *Agaricus rachodes* with that spelling). Props. 117–119 to amend the CODE ask for pre-publication deposit of nomenclatural information in a recognized repository for valid publication of fungal names.

1. Proposals to conserve or reject fungal names *

Proposal 1918:

To conserve the name *Dermatocarpon bucekii*
(*Placopyrenium bucekii*) against *Placidium steineri*
(lichenized *Ascomycota*, *Verrucariaceae*)**

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(1918) *Dermatocarpon bucekii* Nadv. & Servít 1936, BEIH. BOT. CENTRALBL. 55B: 267, **nom. cons. prop.** LECTYPUS (vide Gueidan & al. 2009, TAXON 58: 196): Bulgarien, Rhodope, Karlik Batak, 1800 m, *J. Bucek* (M).

(=) *Placidium steineri* Wetts. 1889, SITZUNGSBERG. KAISERL. AKAD. WISS., MATH.-NATURWISS. CL., Abt. 1. 98: 362. **nom. rej. prop.**
HOLOTYPUS: Pisidien bei Sagalassus, 1885, A. Heider (WU)

Placidium steineri is a forgotten name that applies to a species of the genus *Placopyrenium* Breuss under current generic concepts because of its characters such as subsquamulose thallus, immersed perithecia lacking an involucrellum, and colourless, simple ascospores. This species was described from Antalya

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(turkey) in Wettstein's (l.c.: 348–398) publication, in which a little known list of lichens determined by J. Steiner was published in the second section entitled "Lichenes." The authorship of *P. steineri* has been variously attributed to both Wettstein and J. Steiner. Zahlbruckner (CAT. LICH. UNIV. 1:236. 1921), for example, attributed the name to "Wettst. apud Stnr." Wettstein (l.c.) noted that "Herr Prof. Steiner had die Art als neu erkannt und beschrieben, jedoch nicht bennant; ich benne die Art hiermit ihm zu Ehren [Prof. Steiner has recognized and described the species as new; however he has not named it; I name the species herewith to honour him]". Therefore, as Wettstein was not only the author of the publication but also provided the name, albeit with Steiner providing the description, the authorship is simply *P. steineri* Wettst., accord to Art. 46 of the ICBN (McNeill & al. in REGNUM VEG. 146, 2006).

Placidium steineri was collected from the ancient Greco-Roman town Sagalassus by Adolf Heider. This information is based on the citation in the protologue (Wettstein, l.c.: 362) as "Auf moosigem Boden bei Sagalassus [On mossy soil in Sagalassus]" as well as on the label of the capsule. This locality is situated inside the modern borders of the Antalya province. All collected materials during this expedition of Heider (including fungi, lichens, bryophytes, etc.) are deposited only in the University of Vienna Herbarium (WU) as stated in the original publication (Wettstein, l.c.: 349): "Die der vorliegenden Bearbeitung zu Grunde liegenden Pflanzen befinden sich in Herbare des botanischen Museums der k.k. Universität Wien [The plants upon which the present study is based are deposited in the Herbarium of the Botanical Museum of the K.K. University of Vienna]." Besides, the present author has checked for type materials of taxa described from Turkey and deposited in the Natural History Museum in Vienna (W) and WU after diligent searches in a period of five months (supported by TUBITAK and SYNTHESYS respectively) and only one specimen belonging to *P. steineri* has been seen. Therefore, this is considered here to be the holotype and this specimen was studied. The morphological view of the thallus and anatomical characters such as ascospore and pycnospore shape and size, as well as the thin pycnidia wall show that it is conspecific with *Placopyrenium bucekii* (Nádv. & Servít) Breuss in STUD. GEOBOT. 7 (SUPPL.): 182. 1987, based on *Dermatocarpon bucekii* Nádv. & Servít (l.c.) published only in 1936, while *Placidium steineri* was published about four decades earlier, and thus has priority over the widely adopted name *Placopyrenium bucekii*, according to Art. 11.4 of the ICBN.

However, the name *Placidium steineri* never seems to have been accepted since its original publication, although Zahlbruckner (CAT. LICH. UNIV. 1: 236. 1921) recombined it in *Dermatocarpon* Eschw. as *D. steineri* (Wettst.) Sahlbr. It has also not been included under any name in the regional checklist of the Mediterranean Turkey (John in BOCCONEA 6: 173–216. 1996), or in

local floristic lists for such provinces as Adana, Antalya, and Hatay (e.g., John & Nimis in *TURKISH J. BOT.* 22: 257–267. 1998; Nimis & John in *CRYPTOG. BRYOL. LICHENOL.* 19: 35–58; Tufan & al. in *MYCOTAXON* 94: 43–46. 2005, as supplement in <http://www.mycotaxon.com/>).

On the other hand, *Placopyrenium bucekii* is an uncontested species name in current use, known from the Balkan Peninsula, the Mediterranean Region, SE Asia and Ukraine, and it is included in current floras, e.g., Nimis & Poelt (in *STUD. GEOBOT.* 7: 1–269. 1987); and in modern checklists, e.g., Galun & Mukhtar (in *BOCCONEA* 6: 149–171. 1996), Hafellner & Kashta (in *HERZOGIA* 16: 135–142. 2003), John (in *BOCCONEA* 6: 173–216. 1996), Khodosovtsev (in *UKRAINIAN J. BOT.* 62: 111–114. 2005), Llimona & Hladun (in *BOCCONEA* 14: 1–581. 2001), Prieto & al. (in *BOL. SOC. ARGENT. BOT.* 43: 205–210. 2008), and in numerous regional floras.

As the name *Placopyrenium bucekii* is well established in numerous floras all over the distribution range of the species, the strict application of the ICBN would undoubtedly be undesirable. However, accepting this proposal to conserve it against *Placidium steineri* would allow *Placopyrenium bucekii* to be retained.

Proposal 1919:
To conserve *Lactarius* nom. cons.
(*Basidiomycota*) with a conserved type**

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(1919) *Lactarius* Pers., TENT. DISP. METH. FUNG.: 63. 14 Oct—31 Dec 1797
(‘*Lactaria*’), **nom. et orth. cons.** TYPUS: *L. torminosus* (Schaeff. : Fr.) Pers.
(*Agaricus torminosus* Schaeff.), **typ. cons. prop.**

The genus *Lactarius* (Pers. (1797, l.c.)), as currently circumscribed, is a large mushroom genus with more than 400 currently accepted species (Verbeken 2001, in MICOL. VEGET. MEDIT. 16: 71–88), known in English as milk caps. Until recently, *Lactifluus* (Pers.) Roussel (1806), *Galorrheus* (Fr.: Fr.) Fr. (1825), *Lactariella* Schröter (1889), *Lactariopsis* Henn. (1901), *Gloeocybe* Earle (1909), and *Pleurogala* Redhead & Norvell (1993) were widely accepted as synonyms (Redeuilh & al. 2001, MYCOTAXON 77: 127–143). A significant portion of the known species is included in the modern monographs of Hesler & Smith (1979, N. AMER. SP. LACTARIUS), Heilmann-Clausen & al. (1998: *Lactarius*, FUNGI NORTHERN EUR.), Basso (1999: *Lactarius*, FUNGI EUROPAEI 7), and Verbeken (2008—in prep.: *Lactarius*, FUNGUS FL. TROP. AFRICA 2). Comprehensive taxonomic contributions are also available for Central and South America (1979: Pegler & Fiard, KEW BULL. 33: 601–628; Singer & al. 1983, NOVA HEDWIGIA BEIH. 77: 1–352), South East Asia (Le & al. 2007, FUNG. DIVERSITY 24: 173–224, 27:61–94; Verbeken & Horak 1999 & 2000, AUSTRAL. SYST. BOT. 12: 767–779 & 13: 649–707; Verbeken & al. 2001, SYDOWIA 53: 261–289), Japan (Nagasawa 1998, REP. TOTTORI MYCOL. INST. 36: 36–71) and New Zealand (McNabb 1971, NEW ZEALAND J. BOT. 9: 46–66). Many species are conspicuous and rather easily recognizable in the field and, therefore, included in hundreds of popular field guides in Europe, North America, and Asia (e.g., Phillips 1981,

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MUSHROOMS GREAT BRITAIN EUROPE; Phillips 1991, MUSHROOMS N. AMER.; Imazeki & al. 1988, FUNGI JAPAN) and various local journals. Several sections of the genus include well-known edible fungi that are regularly consumed in many parts of the world (Boa 2004, WILD EDIBLE FUNG.). In the Northern Hemisphere, this concerns especially *Lactarius deliciosus* (L. : Fr.) Gray and closely related species of *Lactarius* sect. *Deliciosus* (Fr. : Fr.) Redeuilh & al., with ongoing research focusing on large-scale production of the edible fruit bodies using artificial mycorrhization of seedlings (e.g., Parlade & al. 2003, MYCORRHIZA 14: 171–175). Mushrooms of the genus *Lactarius* have also been shown to be a good source of bioactive secondary metabolites, especially sesquiterpenes (e.g., Daniewski & al. 1995, PHYTOCHEMISTRY 38: 1162–1168).

A recently published molecular phylogeny of the *Russulaceae* Lotsy (Buyck & al. 2008, FUNGAL DIVERSITY 28: 15–40) demonstrated the existence of four major, phylogenetically distinct clades for the species currently accepted in the genera *Lactarius* and *Russula* Pers. In the same paper, the authors concluded that the most practical solution was to interpret these clades as four distinct genera instead of lumping them in one extremely large genus. Consequently, the few *Russula* species previously assigned to *Russula* sect. *Compactae* subsect. *Ochricompactae* Bills & O.K. Miller, as well as the rare American *Lactarius furcatus* Coker, now constitute the newly described genus *Multifurca* Buyck & Hofstetter (Buyck & al. 2008 l.c.). However, whereas all other *Russula* species remained firmly within a monophyletic ‘*Russula*’ clade, the genus *Lactarius* appears to be paraphyletic, falling into two distinct clades, representing to us two different genera in the *Russulaceae*.

The first genus of milk caps would include the species hitherto classified in *Lactarius* subg. *Piperites* (Fr. ex J. Kickx f.) Kauffman (including *L. torminosus* (Schaeff.: Fr.) Pers. 1797 l.c.: 64, the type of this subgeneric name, as well as *L. deliciosus* [molecularly supported by Eberhardt & Verbeken 2004, MYCOL. RES. 108: 1042–1052; Nuytinck & al. 2003, BELG. J. BOT. 136: 145–153]), *L.* subg. *Russularia* (Fr. ex Burl.) Kauffman, and *L.* subg. *Plinthogali* (Burl.) Hesler & A.H. Sm. (including *L. lignyotus* Fr., lectotype of *Lactariella*). The currently little used subgenera *Lactarius* subg. *Colorati* (Bataille) Bon, *Tristes* Hesler & A.H. Sm., and *Rhysocybella* Bon, as well as all sequestrate forms that hitherto most often were classified in the genera *Arcangeliella* Cavara (1900), *Zelleromyces* Singer & A.H. Sm. (1960), and *Gastrolactarius* J.M. Vidal (2005) also correspond to this clade (Nuytinck & al. l.c.; Eberhardt & Verbeken l.c.; Lebel & Tonkin 2007, AUSTRAL. SYST. BOT. 20: 355–381; Nuytinck & al. 2007, MYCOLOGIA 99: 820–832). Other previously recognized sequestrate genera in *Russulaceae* (*Cystangium* Singer & A.H. Sm., *Elasmomyces* Cavara, *Gymnomyces* Masee & Rodway, *Macowanites* Kalchbr., *Martellia* Mattir.) are synonyms of

Russula (Martín & Calonge 2000, MYCOTAXON 76: 9–15; Miller & al. 2002, MYCOLOGIA 93: 344–354; Lebel & Tonkin l.c.).

The second genus of milk caps would then include the remainder of the old genus *Lactarius*, i.e., the species currently classified in *Lactarius* subg. *Lactarius*, subg. *Lactifluus* (Pers.) Hesler & A.H. Sm. (often with authorship incorrectly written “(Burl.) Hesler & A.H. Sm.” [Art. 33.3]) and subg. *Lactariopsis* (Henn.) R. Heim, and a group not assigned to any subgenus, *L.* sect. *Edules* Verbeken (all molecularly supported by Buyck & al. l.c.), as well as the species of *Lactarius* subg. *Russulopsis* Verbeken, *L.* sect. *Panuoidei* Singer, and *L.* ser. *Gerardii* A.H. Sm. & Hesler (unpub. molecular data).

The currently listed lectotype of *Lactarius*, *L. piperatus*, sits in this latter generic clade. It was first designated type by Earle (1909, BULL. NEW YORK BOT. GARD. 5: 373–451) as pointed out by Donk (1949, BULL. BOT. GARD. BUITENZORG, SÉR III, 18: 271–402) and is currently accepted by most modern authors (e.g., Basso l.c.; Heilmann-Clausen & al. l.c.; Redeuilh & al. l.c.) as well as by the ICBN (APPENDIX IIIB) when the orthography of the genus was conserved (Taxon 37: 457. 1988.) and hence cannot be changed without acceptance of a conservation proposal (Art. 14.8). The total number of described species belonging to this second *Lactarius* clade is much lower than the number of species described in the above-mentioned clade: on a worldwide scale, this second *Lactarius* clade (the one comprising the type, *Lactarius piperatus*) accounts only for about 20% to 25% of the currently described species. This percentage drops to 10% when considering only the better-known subtropical and more temperate zones of Europe, North America, and Asia. In tropical areas, especially tropical Africa, this second clade is much better represented, but most species are recently described and usage of their names is mostly confined to specialist taxonomic literature.

In the literature, we can find two other species names that have been cited as lectotype of *Lactarius*: *L. torminosus* and *L. deliciosus*. *Lactarius torminosus* was cited as type by Singer (1936, ANN. MYCOL. 34: 286–378; 1972, AGARIC. MOD. TAX. 2; 1975, AGARIC. MOD. TAX. 3; 1986, AGARIC. MOD. TAX. 4), Imai (1938, J. FAC. AGRIC. HOKKAIDO IMP. UNIV. 43: 179–378), and recently also by Rayner (2005, BRIT. FUNG. FLORA 8). *Lactarius deliciosus* was used as type by Singer & Smith (1946, MYCOLOGIA 38: 240–299), Singer (1951 (“1949”) AGARIC. MOD. TAX.) and Hesler & Smith (1979 l.c.). Both species to which these names apply are common and well known taxa that belong to the generic clade that does not include *L. piperatus* but, on the other hand, comprises most of the well-known northern hemisphere taxa that are part of the various revisions and monographs of the genus.

Lactarius piperatus is not only the current lectotype of *Lactarius*, it was once considered to be the lectotype for the generic names *Lactifluus* (Pers.) Roussel

(l.c.) and *Galorrheus* (Fr. : Fr.) Fr. In recent literature, both these genus names have exclusively been accepted as historical alternative names for *Lactarius* and as typified by Donk (1962, BEIH. NOVA HEDWIGIA 5: 107–109, 155–156) were treated as nomenclatural synonyms of *Lactarius* (Earle l.c.; Donk 1962 l.c.; Redeuilh & al. l.c.). *Lactifluus* was only used at the generic level by Roussel (l.c.) and Kuntze (1891, REVIS. GEN. PL. 2: 856). Persoon (1800, COMMENT. SCHAEFF.: x) introduced “*Lactifluus*” (nom. invalid., Art. 33.9) as a ‘familia’ and subsequently validly published *Agaricus* sect. *Lactifluus* in 1801 (l.c.). Although Donk (1962 l.c.: 155–156) argued that the infrageneric “*Lactifluus*” was a substitute for *Lactarius* [as *Lactaria*] Pers. (1797 l.c.), because Persoon did not designate a type, *Agaricus* sect. *Lactifluus* is automatically typified by *Agaricus Lactifluus* L. (ART. 22.6), which applies to a species nowadays generally recognized under the sanctioned name, *Lactarius volemus* (Fr. : Fr.) Fr. Typification of the other possible generic name, *Galorrheus*, is controversial, but that generic name is unavailable because it is considered to be an illegitimate later homonym of *Galarhoeus* Haw., *Euphorbiaceae* (1812, SYN. PL. SUCC.: 143).

In order to promote nomenclatural stability in the *Russulaceae* by limiting the number of name changes that could result from the phylogeny recovered by Buyck & al. (l.c.), we now propose to select *Lactarius torminosus* as a conserved type for *Lactarius* as (1) only this species is clearly part of the protologue of the genus (Persoon l.c.); (2) as it is the type of one of the main and most diverse subgenera (*Piperites*) of the genus; (3) as it is also the most ‘typical’ *Lactarius* of the two names that have been mentioned as a lectotype of *Lactarius* in the sense that its whitish milk is the most common latex colour in the genus (as opposed to the orange to red latex of *L. deliciosus* which is almost confined to a few species of *L.* sect. *Deliciosi*); and (4) original material (Schaeffer 1762, FUNG. BAVAR. 1: pl. 12) also cited in the sanctioning work (Fries 1821, SYST. MYCOL. 1: 63) is available and is here designated as lectotype for *Agaricus torminosus* Schaeffer.

The clear advantages of this generitype change are several:

- (1) Most of the species that have been described in the genus would remain in *Lactarius*, avoiding hundreds of combinations with *Lactariella* Schröter, which would become the oldest available generic name for this clade. *Lactariella* is a long forgotten generic name that is combined with only two species epithets for taxa currently classified in *L.* subg. *Plinthogali*.
- (2) Most of the *Lactarius* names used in the less specialized taxonomic literature will not be affected by the new phylogeny. The species of the generic clade that includes *L. piperatus* should then be transferred to *Lactifluus*, as this becomes the oldest unambiguous

generic name available for this clade. A number of required, significant combinations for taxa in the clade already exist with this generic name, namely: *Lactifluus piperatus* (L.) Kuntze, *L. vellereus* (Fr.) Kuntze, *L. deceptivus* (Peck) Kuntze, *L. volemus* (Fr.), *L. hygrophoroides* (Berk. & M.A. Curt.) Kuntze, *L. corrugis* (Peck) Kuntze, *L. gerardii* (Peck) Kuntze, and *L. princeps* (Berk.) Kuntze.

- (3) The polyphyletic sequestrate genera and other species with slightly different morphologies that are now widely considered as synonyms for *Lactarius* and now being gradually abandoned would also remain unaffected.

The only disadvantage of this proposal—as with any genus transfer—is that it is unavoidable to affect at least a few widely used names. However, in our proposal the transfer to a different genus (*Lactifluus*) will be limited to about 90 species, which is considerably less than the several hundred combinations required if the type were not conserved as proposed.

Acknowledgements

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Proposal 1926:
To conserve *Cladia* against *Heterodea* (Ascomycota)**

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(1926) *Cladia* Nyl. in BULL. SOC. LINN. NORMANDIE, sér. 2, 4: 167. 1870,
nom. cons. prop. TYPUS: *C. aggregata* (Sw.) Nyl. (*Lichen aggregatus* Sw.).

(=) *Heterodea* Nyl. in BULL. SOC. LINN. NORMANDIE, sér. 2, 2: 47. 1868,
nom. rej. prop. TYPUS: *H. muelleri* (Hampe) Nyl. (*Sticta muelleri*
 Hampe).

Heterodea was introduced by Nylander (9 Jan–Feb 1868, SYN. LICH. NOV. CALED. re- or pre-printed from BULL. SOC. LINN. NORMANDIE, as cited above) for one species, *H. muelleri* from New Caledonia. A second species, *H. madagascarea* Nyl., was described from Madagascar (Nylander 1888, LICH. NOV. ZEL.: 21). The latter species has subsequently been shown to be unrelated and reduced to synonymy with *Gymnoderma coccocarpum* Nyl. (Jahns & van der Knapp 1973, HERZOGIA 2: 437–451). Subsequently, a further species of *Heterodea* has been described from Australia, bringing the number of accepted species in the genus back to two (Filson 1978, J. HATTORI BOT. LAB. 10: 13–25). The family position of *Heterodea* has remained uncertain. While some authors assumed a relationship with *Parmeliaceae* Zenker based on the foliose growth form (Blackman & al. 1973, BRYOLOGIST 76: 410–413), others placed it in *Cladoniaceae* Zenker (Jahns & van der Knapp 1973, HERZOGIA 2: 437–451; Poelt in Ahmadjian & Hale 1974, THE LICHENS: 599–632). Subsequently, Filson (1978 l.c.: 15) described a monogeneric family to accommodate this genus. However, molecular data showed that the genus is nested within *Cladoniaceae* (Wedin & al. 2000, LICHENOLOGIST 32: 171–187).

The generic name *Cladia* was introduced in a discussion under *Ramalina pumila* subsp. *javanica* Nyl. on p. 69 of a *Ramalina* monograph (RECOGNITIO MONOGRAPHICA RAMALINARUM, reprinted with separate pagination from BULL. SOC. LINN. NORMANDIE, sér. 2, 4: 101–180. 1870) to accommodate three

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species: *Cladia aggregata* and two others referred to only as epithets in the accusative, “*retiporam*” and “*schizoporam*”. No direct references to the basionyms or their authors of the included species were given. However, “*retipora*” and “*schizopora*” were unique published fungal epithets that were applied to lichens before 1870 and therefore there is distinct indirect evidence that their basionyms are *Baeomyces retiporus* Labill. 1806 and *Cladonia schizopora* Nyl. 1860. The existence of several earlier epithets “*aggregata*” (-us, -um) applicable to fungi precludes the same unequivocal recognition of the basionym of *Cladia aggregata*, but since Nylander gave a description both of it (“in *Cladia aggregata* stratum corticale totum ex elementis filamentosis longitudinalibus dense conglutinatum”) and of *Cladia* (“thallo terebrato analogas”), the name is validly published in any case and under Art. 33.3, it can be recognised as based on *Lichen aggregatus* Sw., applicable to the same species (and also the only earlier use of the epithet in what is now recognised as the family *Cladoniaceae*).

Because three validly published species names were referred to indirectly (Art. 10.3) in the protologue, a lectotypification for *Cladia* was required, and Filson (1981, J. HATTORI BOT. LAB. 49: 1–75) was apparently the first to lectotypify *Cladia* with *C. aggregata*. However, as Nylander did not definitely associate their epithets with the generic name *Cladia* (Art. 33.1) the combinations *Cladia retipora* (Labill.) Nyl. and *C. schizopora* (Nyl.) Nyl. were not technically validly published with the protologue of *Cladia* but were validated later.

Subsequently, a number of additional species were described and currently 14 species are accepted (Ahti 2000, FL. NEOTROP. MONOGR. 78: 1–362; Filson 1981 l.c., 1984, LICHENOLOGIST 16: 94–96, and 1992, FL. AUSTRAL. 54: 101–107; Kantvilas & Elix 1987, MYCOTAXON 29: 199–205, and 1999, MUELLERIA 12: 135–162). The genus was classified in *Cladoniaceae* (Henssen & Jahns 1973 [1974], LICHENES: 311; Poelt, l.c.) or in a separate family *Cladiaceae* (Filson 1981, l.c.). Molecular data showed that the genus *Heterodea* is nested in *Cladoniaceae* (Wedin & al. l.c.), where it is currently placed (Lumbsch & Huhndorf 2007, MYCONET 13: 1–58).

In a recent molecular study (Parnmen & al. 2010 in press, TAXON 59) we demonstrated that the genus is nested within *Cladia*. Consequently, the two genera cannot be kept separate and are best regarded as congeneric. The genera also share the same type of ascoma structures, vegetative anatomical structures, and secondary metabolites. The genus *Heterodea* includes only two currently accepted species that are restricted to Australasia, while *Cladia* includes 14 species with a wide distribution in the Southern Hemisphere and one pantropical species. Over the last decades, the generic name *Cladia* has been widely used in numerous standard floras, checklists, and other publications (Ahti l.c.; Filson 1992 l.c.; Galloway 2007, FL. NEW ZEALAND LICHENS, ed. 2; Harada & al. 2004, LICHENOLOGY 2: 47–165; Kurokawa & Kashiwadani 2006, CHECKL. JAP.

LICHENS: 157; Malcolm & Galloway 1997, NEW ZEALAND LICHENS: Checkl., Key Glossary: 192; McCarthy 2003, CAT. AUSTRAL. LICHENS: 237; Wolseley & al. 2002, BULL. BRIT. MUS. (NAT. HIST.) BOT. 32: 13–59). No authors have ever included *Cladia* in *Heterodea*. In order to avoid numerous name changes in a well-established genus we propose *Cladia* for conservation against *Heterodea*.

Proposal 1927:
To conserve the name *Agaricus rachodes* (*Basidiomycota*)
with that spelling**

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(1927) *Agaricus rachodes* Vittad., DESCR. FUNG. MANG.: 158. 1833 ('1835'),
orth. cons. prop.

Chlorophyllum rachodes (Vittad.) Vellinga is a common, widespread and edible mushroom species, whose name has been challenged by the alternative spelling 'rhacodes'.

In a separate paper (Vellinga & Pennycook 2010 in press, TAXON 59) we outlined the history of the usage of the epithet '*rachodes*' and its challenger '*rhacodes*', and the range of potential etymologies, transliterations, and orthographies of these two epithets. Recapitulating briefly: Vittadini (1833, DESCR. FUNG. MANG.: 158) described *Agaricus rachodes*, without an etymology either explicit or implied, but using that spelling of the epithet consistently. The variant spelling, '*rhacodes*' was first introduced by Fries (1849, SUMMA VEG. SCAND.: 273) who alternated between the two spellings during his lifetime. After Saccardo's (1887, SYLL. FUNG. 5: 29) listing of the spelling '*rhacodes*', this became the more commonly used spelling in Europe until the late 20th century, when it was reiterated that '*rachodes*' was the correct original spelling (Candusso & Lanzoni 1990, LEPIOTA. FUNGI EUR. 4: 536; De Kok & Vellinga 1998, PERSOONIA 17: 70). Outside Europe, '*rachodes*' remained the more commonly used spelling during the 20th and into the 21st centuries (e.g. Kauffman 1924, PAP. MICH. ACAD. SC. ARTS LETTERS 4: 328; Imazeki & Hongo 1962, COLOUR. ILL. FUNG. JAPAN: 48; May & Wood 1997, FUNGI AUSTRALIA 2A: 105; Pennycook 2004, FUNGI NEW ZEALAND 1: 192).

As Vittadini did not publish an etymology we have to guess at the meaning this word had for him. Two possible roots for the epithet are the Greek words 'ρακος' (rag) and 'ραχος' (bush, quickset hedge); the derivations and transliterations of these can be spelled as '*racodes*', '*rhacodes*', '*rachodes*', and '*rhachodes*'.

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Article 60.1 of the ICBN (McNeill & al. 2006, REGNUM VEG. 146) requires that “the original spelling of a name or epithet is to be retained”, with the exception of typographical and orthographical corrections (plus a short list of typographical and grammatical standardisations, which does not include the transliteration of Greek words) and Art. 60 Ex. 1 exemplifies the fact that this does not permit the introduction of corrections based on “philologically preferable” forms. Article 60.3 discourages the introduction of corrections that change the first syllable of a name, another reason to retain the original spelling. Vittadini (1833, DESCR. FUNG. MANG.: 158-162) was consistent in his use of ‘*rachodes*’ in the Latin text and ‘*racode*’ in the Italian. Furthermore, the original spelling has remained in use throughout the time since the original description. It is true that currently the spelling ‘*rhacodes*’ is used twice as often as ‘*rachodes*’ (based on an internet based search engine; ‘*rhacodes*’ hits include some plant and algal genera). However, the two most influential fungal websites, Index Fungorum and Mycobank, both adopt the alternative spelling ‘*rhacodes*’, and we expect that the numbers would begin to change if those authoritative institutions were to reintroduce the original ‘*rachodes*’, just as they did over a century earlier in Europe after Saccardo’s *Sylloge Fungorum* listed ‘*rhacodes*’.

To end a longstanding nomenclatural dispute, we here formally propose to conserve the name *Agaricus rachodes* with the original spelling under ICBN Article 14.11—this epithet spelling has remained constantly in use throughout the name’s 175 year history; a philological justification for the change to ‘*rhacodes*’ cannot be sustained because of the unknown etymology; and ICBN Articles 60.1 and 60.3 clearly support the retention of the original spelling.

2. Proposals to amend the CODE *

Proposals 117–119:

**To make the pre-publication deposit of key nomenclatural information
in a recognized repository a requirement for valid publication of
organisms treated as fungi under the CODE ****

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Mycologists first proposed the introduction of some form of a mandatory indexing system for newly proposed fungal names in the 1950s (Ainsworth & Ciferri 1955, *TAXON* 4: 3-6). Following informal discussions amongst mycologists – particularly during the 7th International Mycological Congress in Oslo in 2002 – the CBS-Fungal Diversity Centre in Utrecht initiated MYCOBANK in 2004 (Crous & al. 2004, *MYCOL. RES.* 108: 1236–1238; Crous & al. 2004, *STUD. MYCOL.* 50: 19–20). This step was taken in order to test the willingness of mycologists to use a depository system where they could place information on new scientific names they were proposing. MycoBank is a fully online system whereby the proposers of new scientific names of organisms treated as fungi under the CODE (i.e. including chytrids, oomycetes, and slime moulds; Pre-7 of the ICBN; McNeill & al. 2006, *REGNUM VEG.* 146) can deposit key information that becomes public and freely available on the worldwide web only after effective publication of the work including those names. Each name is assigned a unique number from a range made available by Index Fungorum to MycoBank. (Index Fungorum is a partnership of CAB International, CBS-KNAW Fungal Diversity Centre, and Landcare Research that offers a freely available nomenclator of fungal names in all ranks online to the public. As of January 2010, the Index Fungorum database held information on 450,280 names; see <http://www.indexfungorum.org/>.)

MycoBank operates similarly to GenBank, which provides unique identifiers for molecular sequence data. MycoBank does not require any hard-copy material to be lodged at CBS or elsewhere, but serves to disseminate information on newly proposed taxa widely and rapidly at no cost to all users, whether they are depositors or interrogators. Since 2007, MycoBank has operated under the auspices of the International Mycological Association (IMA), which has assumed long-term responsibility for its operation. Like IAPT, IMA is a Scientific Member of the International Union of Biological Sciences (IUBS).

Scientific names in all ranks are covered in the existing MycoBank system. The basic information required for deposition of a newly described taxon is the name itself, the validating Latin (or for fossil fungi, English) description or diagnosis, details of the nomenclatural type, and (for species and infraspecific taxa) where the type is permanently preserved. New combinations and replacement names require only the full bibliographic reference to the basionym or replaced name, as already specified by Art. 33.4. MycoBank personnel check the uniqueness of the name, alert the depositor to any earlier homonym, and draw attention to orthographic errors (such as incorrect Latin terminations), but do not express any taxonomic opinions; i.e. there is no censorship. Index Fungorum, as the body issuing unique numbers for fungal names, automatically receives a copy of all nomenclatural information deposited in MycoBank.

Depositors are additionally encouraged – but not required – to provide available information (e.g. GenBank accession identifiers, where living cultures are deposited, detailed descriptions, illustrations, other comments, or a copy of in-press publications). After publication, the actual volume and page references can be inserted in the MycoBank database, and some publishers (e.g. ELSEVIER, MYCOTAXON) have indicated that they have no objection to the full text of published articles being attached, for example as Portable Document Format files (PDFs).

MycoBank and Index Fungorum are now favourably and almost universally accepted by the mycological community (Stalpers & al. 2009, BULL. ZOOL. NOMENCL. 66: 14–17). The proportion of newly proposed names deposited in MycoBank is increasing: in 2005, 353 of 1893 new fungal names introduced that year were deposited (i.e. 19 %); in 2006, 857 of 2339 (37 %); in 2007, 1392 of 2436 (57 %); in 2008, 1292 of 2342 (55 %); and in 2009, 1666 (the total for the year is not yet available from the INDEX OF FUNGI). Further, TAXON and the leading mycological journals that regularly publish new scientific names of fungi now require authors to deposit information in MycoBank and cite the MycoBank reference numbers as a condition of publication. These journals include: THE BRYOLOGIST, CZECH MYCOLOGY, FUNGAL BIOLOGY (formerly MYCOLOGICAL RESEARCH), FUNGAL DIVERSITY, GRAPHIS SCRIPTA, THE LICHENOLOGIST, MYCOLOGIA, MYCOLOGICA BALCANICA, MYCOLOGY, MYCOSCIENCE, MYCOSPHERE, MYCOTAXON, NOVA HEDWIGIA (lichen papers), OPUSCULA PHILOLICHENUM, PERSOONIA, STUDIES IN MYCOLOGY, and SYDOWIA.

The attitudes of individual mycologists to the existing MycoBank system and other nomenclatural issues were explored by questionnaires distributed at three major mycological meetings in August–September 2007: nomenclatural sessions or symposia at the Mycological Society of America annual meeting (Baton Rouge, Louisiana), the XV Congress of European Mycologists (St Petersburg, Russia), and the XVI Simposio Botánica Criptogámica de España (Léon, Spain). A total of 95 ballots were completed from this geographically dispersed spectrum of mycologists. All did not vote on all issues, but of those voting, 85 % (73) were in favour of making deposit in MycoBank mandatory for the valid publication of new fungal taxa (Hawksworth 2007, MYCOL. RES. 111: 1363–1364). Further, in July 2008 the International Association for Lichenology (IAL), meeting in Asilomar, California, passed a resolution endorsing the establishment of MYCOBANK under the auspices of the IMA, encouraging lichenologists to deposit information on newly recognized taxa in it, and urging editors who had not yet done so to make such deposits a condition of publication.

The proposals below aim to incorporate into the CODE what has become the regular practice of most mycologists and of key mycological journals. If accepted, the proposals made here will benefit the entire mycological community, which then will be assured of immediate and complete access to the key nomenclatural information on new fungal names proposed after 1 January 2013.

This will be of enormous and immediate benefit to the discipline, because mycology now has an almost complete catalogue of fungal names in INDEX FUNGORUM (www.indexfungorum.org), and this new proposal will mean mycologists have access to a free, ongoing, and continuously updated repository for new fungal names. There is already a major lag in the time between publication of a name and appearance in the printed twice-yearly INDEX OF FUNGI; the latest issue (July 2009) comprises only names published in 2008 and before. As mycology no longer has any institution with the resources to search out all names from the literature, do-it-yourself repositories provide a relatively easy and effective mechanism to establish and maintain an accurate and up-to-date list of fungal names.

We wish to draw attention to two differences between the proposals made here and previous proposals on the “registration” of botanical names: (1) there is no requirement to submit printed matter (including protologues) to a registering office designated by the International Association for Plant Taxonomy (IAPT) as proscribed in the text incorporated into the TOKYO CODE (Art. 32.2); and (2) the deposit of names is restricted to their author(s) and deposition by third parties of newly proposed names is not allowed after the requirement becomes mandatory, contrary to the proposals of Borgen & al. (TAXON 1998, 47: 899–904). Technological advances since 1996 have rendered the first requirement superfluous, and author-restricted deposition and activation clarifies author intent. However, the proposals do not preclude others depositing information on names proposed prior to 1 January 2013 after that date. The deposit of nomenclatural information in a recognized repository, as proposed below, does not obviate the need for author(s) to fulfil the current requirements of the CODE in relation to effective publication (Art. 29.1), nor does it affect the date of effective publication (Art. 31.1).

We forward these proposals at this time so that they will be available for debate at the Nomenclature Session to be convened during the IX International Mycological Congress in Edinburgh in August 2010. We shall transmit the outcomes of that debate to the Nomenclature Section meetings at the International Botanical Congress in Melbourne in July 2011 for final decision.

We wish to emphasize that, while most of us making these proposals have, or have recently held, positions in international mycological organizations or committees, we make them here in our personal capacities in anticipation

of their consideration by mycologists as a whole at the forthcoming 9th International Mycological Congress.

(117) Add a new Article 37bis:

“37bis.1. For organisms treated as fungi under this CODE (Pre.7), from 1 January 2013 the citation of an identifier issued by a recognized repository (Art. 37bis.3) in the protologue is an additional requirement for valid publication.

37bis.2. For an identifier to be issued by a recognized repository as required by Art. 37bis.1, the minimum elements of information that must be accessioned by author(s) of scientific names are those required for valid publication under Art. 32.1 (b-e).

Note 1. Issuance of an identifier by a recognized repository based upon the presumed future fulfilment of requirements under Art. 32.1 (b-e) does not in itself constitute or guarantee a valid publication of a proposed name; that can occur only on effective publication (Art. 29) if the requirements of Art. 32.1 (b-e) are simultaneously fulfilled in that publication.

37bis.3 The Committee for Fungi (Div. III.2 (4)) has the power to: (1) appoint one* or more localized or decentralized open and accessible electronic repositories to perform this function*; (2) remove such repositories at its discretion; and (3) set aside the requirement to deposit information on newly proposed scientific names for organisms treated as fungi under the CODE in a recognized repository, should the repository mechanism, or essential parts thereof, cease to function. Decisions made by the Committee under these powers are subject to ratification at the subsequent International Mycological Congress.

* The only current operational repository appointed is MycoBank
(www.mycobank.org).

The Editorial Committee may wish to consider combining the existing Arts 38 and 39, both of which deal with illustrations, to avoid changing the numbering of subsequent articles in the CODE. In addition, the Committee is also requested to: (1) change “International Mycological Congress” to “International Botanical Congress” in the proposed Art. 37bis.3 should Props 016-020 (Hawksworth & al. 2009, TAXON 58: 658-659; Hawksworth & al. 2009, MYCOTAXON 108: 1-4) not be accepted by the Nomenclature Section; and (2) revise the wording of the proposed footnote as necessary to take account of any decisions on repositories made by the Committee for Fungi prior to the publication of the Melbourne Code.

(118) Insert a new Recommendation 37bisA.1:

“*37bisA.1.* Authors of names of organisms treated as fungi under this CODE are encouraged to: (a) deposit minimal elements of information in relation to the names in a recognized repository, and obtain accession identifiers, as soon as possible after their papers are accepted for publication; and (b) after the effective publication of the name, inform the recognized repository of the complete bibliographical details, including for example, the volume, part number, page number, date of publication, and (for books) the publisher and place of publication.”

(119) Insert a new paragraph Art. 33.1bis:

“*33.1bis.* On or after 1 January 2013, in the case of organisms treated as fungi under this CODE, the citation of a repository identifier (Art. 37bis.1) for the new combination or new name in the publication in which it is introduced is required for valid publication.”

Acknowledgement

We are indebted to John McNeill (Edinburgh) for particularly constructive comments made during the preparation of this set of proposals.

Proposals 090–091:
To add two examples on the valid publication
of the names of higher-level taxa.

UPDATE—The proposals to add two examples on the valid publication of the names of higher level taxa (Redhead 2009: MYCOTAXON 110: 503–504, 2010: TAXON 59: 308–309) were still not numbered when the 2009 October–December MYCOTAXON was sent to press. At that time, we informed MYCOTAXON readers that we would announce the official numbers in MYCOTAXON 111. The above proposals to amend the CODE are now formally referred to as Props. 090–091.

—Lorelei Norvell, MYCOTAXON *Editor-in-Chief*

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- Roberts, Rodney G., Stephen T. Reymond & Birgitte Andersen. *Alternaria cerasidanica* sp. nov. isolated in Denmark from drupes of *Prunus avium*. 111: 175–182. 2010.

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- Uzun, Yusuf, Kenan Demirel, Abdullah Kaya & Fahrettin Gücin. Two new genus records for Turkish mycota. 111: 477–480. 2010.
- Vellinga, Else C. & Shaun R. Pennycook. Prop. 1927: To conserve the name *Agaricus rachodes* (*Basidiomycota*) with that spelling. 111: 512–513. 2010.
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p.421, line 18	<i>for:</i> 8.7–10(11.2)....[L = 8.05–10.04 µm; L' = 9.46 µm; W = 6.85–8.4 µm; W' = 7.76;...
	<i>read:</i> (7.2)8.7–10.0(11.2).... [L = 8.7–10.0 µm; L' = 9.5 µm; W = 6.8–8.4 µm; W' = 7.8; ...

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p.vii, line 4	<i>for:</i> (EDITOR) 507	<i>read:</i> (EDITOR) 509
p.566, line 9	<i>for:</i> <i>Septosporiopsis elaeidis</i> ?	<i>read:</i> <i>Septosporiopsis elaeidis</i>

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p.325, 4 th from bottom	<i>for:</i> ..., Trappe et al. 2009)	<i>read:</i> ..., Trappe et al. 2010)
p.326, line 2	<i>for:</i> (Trappe et al. 2009)	<i>read:</i> (Trappe et al. 2010)
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FROM THE *EDITOR-IN-CHIEF*

MYCOTAXON 111—The 536-page January–March volume presents 91 new fungal names and 65 papers by 206 authors and co-authors representing 35 countries and assisted by 115 expert reviewers. Submissions continue at last year’s high, with 48 new manuscripts accessioned during 2010 as of today. After closure of this volume, we already have 43 final submissions tentatively scheduled for publication in the April–June volume.

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Those interested in obtaining or writing book reviews are invited to contact *Book Review Editor* Else Vellinga at <bookreviews@mycotaxon.com>.

NOMENCLATURE—We invite anyone wishing to comment on a nomenclatural proposal now under consideration by the IAPT Permanent Nomenclature Committee for Fungi to submit short opinion papers for publication in Mycotaxon’s new Nomenclature Section (pp. 501–520, this volume). Such opinions will also be shared with the Committee for Fungi, which sends its final recommendations to the General Committee for a final decision by the Nomenclature Section at the International Botanical Congress in Melbourne in 2011.

MYCOTAXON BIDS ADIEU TO FRENCH-LANGUAGE MANUSCRIPTS—Since ‘founding fathers’ Grégoire Hennebert (Belgium) and Dick Korf (USA) established our journal in 1974, we have offered authors the opportunity to publish in English or French. Lately, however, very few French papers have been submitted, with only four French manuscripts having been received by me since October 2003. After considerable discussion in November, the *Editorial Advisory Board* recommended that MYCOTAXON change its policy and henceforth accept only English language submissions. Varying degrees of regret were expressed at the change, but the majority view was that English is “now (for better or worse) the major language of scientific discourse [and] that there is no longer any particular reason why MYCOTAXON should make an exception for Francophone authors that is not extended to speakers of any other non-English language.”

The Editors agree (somewhat reluctantly) with the Board, making Serge Audet’s thoughtful 36-page study of *Scutigera* sensu lato (this volume, pp. 431–464) the final French-language paper to be published by MYCOTAXON. We thank former and current *French Language Editors* Grégoire Hennebert and Cony Decock for their editorial contributions to the first 110 MYCOTAXON volumes.

Warm regards,

Lorelei Norvell,

MYCOTAXON *Editor-in-Chief*

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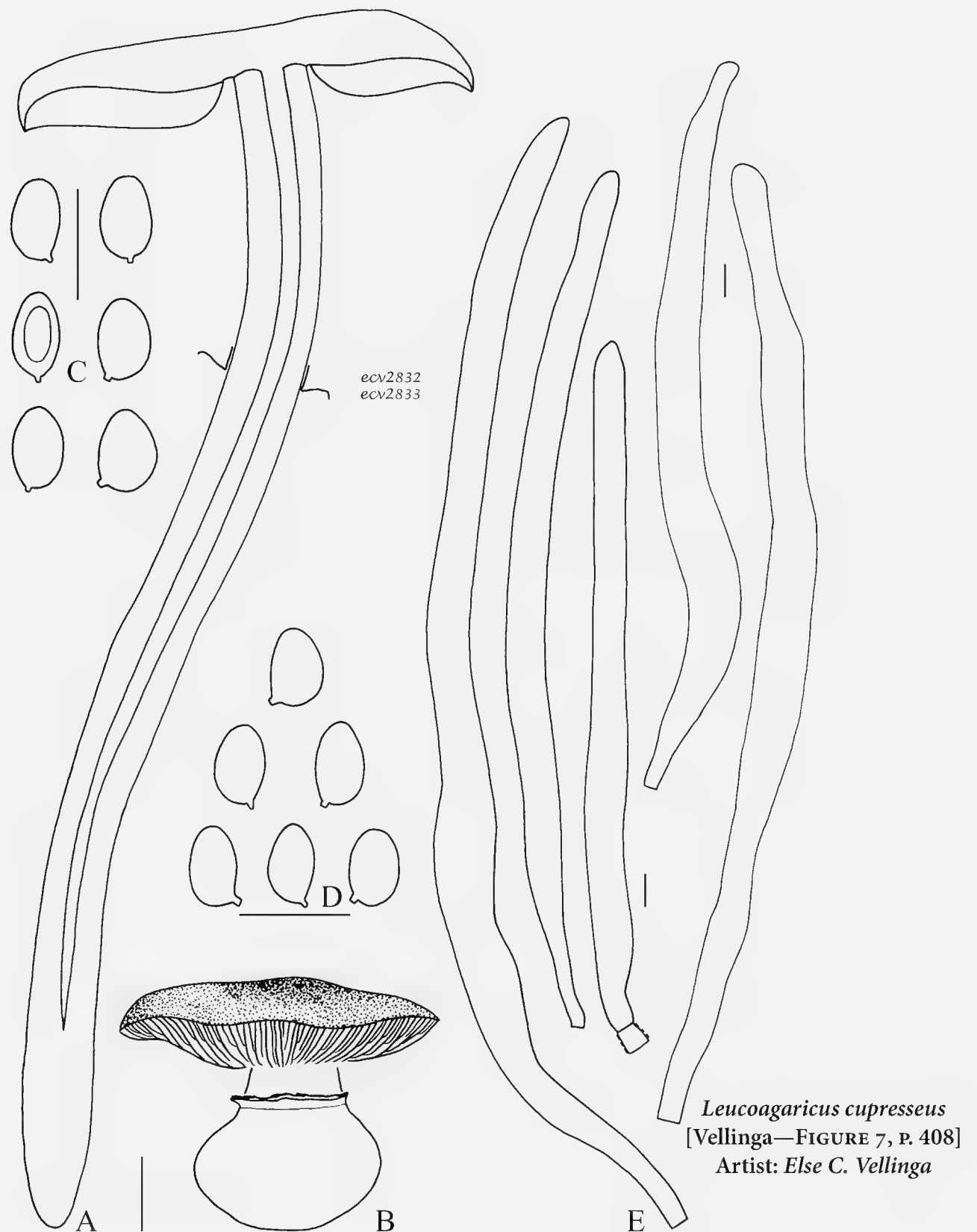
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Type specimens in the Mycological Herbarium “Albert S. Muller” (VIA), Venezuela

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Abstract — One hundred and ninety four type specimens held in the Mycological Herbarium “Albert S. Muller” (VIA) are listed. Ninety-eight relate to anamorphic fungi, 59 to *Ascomycota*, 36 to *Basidiomycota*, and one to *Oomycota*. The complete annotated collection list is available on: <http://www.mycotaxon.com/resources/weblist.html>.

Key words — Latin America, Neotropical fungi, reference collections

Introduction

The dried fungal reference collections in Latin America have been consistently neglected. Some important collections survive, but they remain little known even when holding valuable material, particularly type specimens that are essential in systematic research and the revision of taxa.

One example is the Mycological Herbarium “Albert S. Muller” (VIA) at the Instituto Nacional de Investigaciones Agrícolas of Venezuela. Founded in 1937, VIA remained inactive for almost 40 years (between 1941 and 1982) in the absence of systematic mycologists.

The reorganization of the herbarium, initiated in 1982, has involved several activities to fulfill basic requirements, such as finding an adequate space for the specimens, founding a library and a laboratory, and training of human resources. These tasks are still in progress.

An inventory of the original herbarium reveals that although much previously listed (Ciccarone 1948) material has been lost, some nomenclatural types remain among the specimens, including many from Venezuela.

An updated list of the VIA types is provided in this paper.

Materials and methods

Label information was recorded from all “type”-designated specimens. Original descriptions were scanned in order to confirm protologue data. When the literature associated with protologues was checked, some other holotypes and paratypes deposited in VIA and not previously labeled as “types” were detected.

Collections designated as “sp. nov.” bearing names that could not be traced in the literature or in Index Fungorum (2008) are not included in the list. Holotype, isotype, lectotype, paratype, syntype, topotype, and similar terms have been included whenever this condition was clearly confirmed for the specimen, either on its label or in scanned related publications (electronic or printed). Information about hosts, collection sites, names of collectors, dates of collection and acronyms of reference collections holding duplicates are included.

The fungal taxa are systematically arranged in accordance with Index Fungorum (2008); abbreviations of authors of fungal names are given according to Kirk & Ansell (1992). Acronyms of reference collections follow Holmgren & Holmgren (2008).

Results

One hundred and ninety four type specimens are listed. Ninety-eight relate to anamorphic fungi, 59 belong to *Ascomycota*, 36 to *Basidiomycota*, and one to *Oomycota*. A summary is presented below, and the complete annotated specimen list is available on

<http://www.mycotaxon.com/resources/weblist.html>.

[Types from Venezuela are indicated by an asterisk (*).]

Acremonium exiguum, *Aecidium hymenocallidis**, *Anthracoidea unciniae**,
*Antimanoa grisleae**, *Asteridiella vilis* var. *caracacensis**, *Asterina*
*orthosticha**, *Asterinella bredemeyerae**, *Auerswaldiella disciformis**;
*Bagnisiopsis towarensis**, *B. translucens**, *Burrillia sagittariae**;
*Calothyrium jahnii**, *Cercospora alabamensis*, *C. angolensis*, *C. apiicola**,
C. aragonensis, *C. aurantia*, *C. batatas* Henn., *C. beticola*, *C. carbonacea*,
C. cordobensis, *C. crotalariae* Syd.*, *C. curatellae**, *C. cyclantherae**,
C. cylindrata, *C. dioscoreae-bulbiferae*, *C. ecliptae**, *C. fagopyri* Chupp &
A.S. Mull.*, *C. fuchsiae**, *C. fusimaculans*, *C. hyptidicola**, *C. ipomoeae*,
C. ipomoeae-pedis-caprae, *C. ipomoeae-purpureae*, *C. jaguarensis**,
*C. lanugiflori**, *C. lonchitidis**, *C. marcelliana**, *C. melanotes**,
*C. mirandensis**, *C. monochaeti**, *C. nubilosa*, *C. oldenlandiae*,
*C. oxalidiphila**, *C. pachyderma*, *C. passifloricola**, *C. pittieri**,
*C. poinciana**, *C. salpianthi**, *C. sorghi*, *C. spilosticta**, *C. stuckertiana*,
C. tokoroi, *C. triumfettae**, *C. turbinae*, *C. uramensis**, *C. viridula*,
C. zae-maydis, *Cercospora indica*, *C. ugandensis*, *C. yadavii*,
*Cercosporidium venezuelanum**, *Cicinnobella heterothea**, *Cintractia*

oreoboli, *Colletotrichum jahnii**, *Cordyceps venezuelensis**,
*Creonectria discostiolata**, *C. macrosporicola**, *Cyclomyces gigas**;
Dactylaria dioscoreae, *Dermatosorus cyperi**, *Diabolidium calliandrae**,
*Dialacenum cissi**, *Dimeriellina nervisequens**, *Doassansia epilobii*;
*Elsinoë pruni**, *Eutypella aggregata**;
*Glabrotheca aciculisporea**, *Glomerella erythrinae**, *Goplana ribis-andicolae**;
*Hemidothis pittieri**;
*Leptosphaeria cryptica**, *Leptospora lignicola**, *Leptosporina aciculospora**;
Macrosporium dioscoreae, *Melampsora euphorbiae-geniculatae**,
*Meliola venezuelana**, *Mycosphaerella erythrnicola**, *M. fijiensis*,
M. fijiensis var. *difformis*, *M. pittieri**, *M. samaneae**, *M. venezuelensis**,
*Mycovellosiella boldoae**, *M. deigtonii*, *M. fujikuroi*, *Myrothecium*
*renaudii**;
*Oberwinkleria anulata**, *Oedothea vismiae**, *Ovulariopsis passiflorae**;
*Passalora bunchosiae**, *P. caracasana**, *P. centrosematis**, *P. monninae**,
*P. securidacae**, *Pestalotia palmarum*, *Phaeoramularia ciccaronei**,
*P. rauvolfiae**, *Phakopsora randiae**, *Phoma heterospora*, *P. sacchari*
Gutner, *P. saccharina*, *Phomatospora oyedaeae**, *Phomatosporopsis*
*ingae**, *Phyllachora cedralensis**, *P. coutareae**, *P. diminuta**,
*P. gelatinosa**, *P. panici-olivacei**, *P. pappophori**, *P. paritii-tiliacei**,
*P. phari-latifoliae**, *P. saurauicola**, *P. venezuelensis**, *Phyllosticta*
*capparidis**, *P. manihot*, *P. manihoticola*, *P. manihotis*, *P. sacchari*,
P. saccharicola, *Pittierodothis miconiae**, *Plasmopara venezuelana**,
*Polyrhizon capparidis**, *Prospodium araguatum**, *P. cumminsii**,
*Pseudocercospora annonae-squamosae**, *P. blechi**, *P. conocarpi**,
*P. durantae**, *P. pachirae**, *P. rhinocarpi**, *P. samaneae**, *P. struthanthi**,
*P. tovariae**, *Puccinia chaetii**, *P. mirandensis**, *P. ponsae**,
*P. waltheriae**, *Pucciniopsis anacardii**;
Ragnhildiana tranzschelii, *Ramularia dioscoreae*, *R. ipomoeae*,
*Ravenelia mirandensis**, *R. verrucata* var. *apurensis**;
*Schiffnerula towarensis**, *S. trematis**, *Septoria araguata**, *S. pittieriana**,
S. versicolor, *Sphaceloma manihoticola*, *Sphaeropsis sacchari*,
Sporidesmium dioscoreae, *Sporisorium absconditum**, *S. panici-*
*hirticaulis**, *S. trachypogonis-plumosi**, *Stenella araguata**;
*Telimena caudata**, *Tilletia brachypodii-mexicani**, *Trabutia saurauiae**;
*Uredo combreti**, *U. lycoseridis**, *U. merremiae**, *U. monochaeti**,
U. paraphysata F. Kern & Thurst. *, *U. pehriae**, *U. verruculosa**,
*Uromyces tripsaci**, *Ustilago longiseti*, *U. shastensis*; and
*Xenomeris eucalypti**.

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Marlyn Arana and Carla Figueroa are thanked for support in locating and photocopying literature and help in the search for information in electronic databases. The authors gratefully acknowledge José Carmine Dianese and David W. Minter for pre-submission review.

Literature cited

- Ciccarone A. 1948. Catálogo Sistemático de los hongos depositados en la Micoteca del Departamento de Fitopatología, MAC, Dirección de Agricultura, Maracay, Venezuela Mimeographed document. 281 p.
- Holmgren PK, Holmgren NH. 2008. Index Herbariorum. A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>
- Kirk PM, Ansell AE. 1992. Authors of fungal names. Index of Fungi Supplement. CAB International. Wallingford. 95 p.
- Index Fungorum. 2008. <http://www.indexfungorum.org/Names/Names.asp>

***Phallus roseus*, first record from the neotropics**

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Abstract — *Phallus roseus* is cited for the first time from the neotropics being found in the semi-arid Brazilian region. Detailed description and illustrations are presented.

Key words — *Phallaceae*, taxonomy, stinkhorn, fungi, Brazil

Introduction

The genus *Phallus* is the most representative of the family *Phallaceae* Corda with 25 species distributed worldwide (Calonge 2005). Eight species have been recorded for the neotropics: *Phallus atrovolutus* Kreisel & Calonge (Calonge et al. 2005a), *P. galericulatus* (Möller) Kreisel (Rocabado et al. 2007), *P. glutinolens* (Möller) Kuntze (Trierveiler-Pereira et al. 2009), *P. hadriani* Vent. (Calonge et al. 2005b), *P. impudicus* L. (Calonge et al. 2005b), *P. indusiatus* Vent. (Calonge et al. 2005b, Rocabado et al. 2007, Baseia et al. 2006), *P. ravenelii* Berk. & M.A. Curtis (Calonge et al. 2005b), and *P. pygmaeus* Baseia (Baseia et al. 2003). Studies on *Phallus* from Brazil are few, and so far six species have been described from Brazil (Trierveiler-Pereira et al. 2009).

Phallus roseus was originally described from Egypt by Delile in 1813 (Dring 1964). Fischer included the species in the genus *Itajahya* Möller based on morphological characters such as the presence of a calyptra, a flat structure at the apex of the pileus. Later, Kreisel (1996) considered *Itajahya* as a subgenus of *Phallus*, given that it exhibits many common characteristics, such as the shape and configuration of the pileus surface, receptacle consistency, and gleba odor.

Material and methods

Field expeditions were conducted at the Estação Ecológica do Seridó, located at the district of Serra Negra do Norte, Rio Grande do Norte State, (6°33' – 6°37' S and 37°14' – 37°16' W), covering an area of 1,166.38 ha. Collections were made during the rainy period, between February and July 2008. The region presents a semi-arid climate with a xerophytic vegetation known as Caatinga. The annual rainfall is under 1,000 mm, normally with an amount between 250 and 800 mm distributed in a short period of 3–6 months (Velloso et al. 2002). The collection of *Phallus roseus* was photographed and examined in the field. The taxonomic study followed the techniques used by Miller & Miller (1988). Species identification was based on the following literature: Kreisel (1996), Baseia (2003), Calonge (2005), and Baseia et al. (2006). The terminology used followed that proposed by Kirk et al. (2008). Colour standardization was from Kornerup & Wanscher (1978). The spores were examined under a Phillips XL 30 scanning electron microscope (SEM) and a Motic BA200 optical microscope (OM). The collection was deposited in the UFRN herbarium.

Phallus roseus Delile, Descr. Égypte, Hist. Nat. 2: 300. 1813.

FIG. 1

≡ *Itajahya rosea* (Delile) E. Fisch., Ber. Dtsch. Bot. Ges., 47: 294. 1929.

Egg subglobose or pyriform, 3–4 cm high by 2–2.5 cm wide, white to yellowish-brown (5A2), with developed rhizomorph. Basidioma 7–10 cm tall. Receptacle cylindrical, 1–1.5 cm tall and 2–2.5 cm wide, surface smooth. Pseudostipe pink (11A2), with remnants of exoperidium on the surface, spongy, hollow, cylindrical, 3–4.5 cm tall and 1.5–2 cm wide, formed by pseudoparenchymatous cells; calyptra pink (11A2) at the apex. Volva subglobose, with superficial layer constituted by pseudoparenchymatous cells; inner layer formed by hyphae. Gleba mucilaginous, olive (2F4). Spores elliptic, $3.0\text{--}3.5 \times 1.8\text{--}2.0 \mu\text{m}$; hyaline; smooth.

HABITAT: rocky soil with direct sun exposure.

MATERIAL EXAMINED: BRAZIL. RIO GRANDE DO NORTE: SERRA NEGRA DO NORTE. Estação Ecológica do Seridó, 06°35'02"S, 37°17'02"W, 202 m high, 23-V-2008, leg. T. Ottoni, 535 (UFRN), 800034 (URM).

DISTRIBUTION: Africa, Southern Yemen, North America, Southern France, Israel, India, and Pakistan (Dring 1964, Mornand 1986, Kreisel 1996, Kreisel & Al-Fatimi 2008).

TAXONOMIC REMARKS: The most diagnostic characteristics of *Phallus roseus* are the presence of a calyptra at the apex of the receptacle and a pink pseudostipe. The latter distinguishes *P. roseus* from *P. galericulatus*, which exhibits a white pseudostipe (Dring 1964 & Kreisel 2008). Fischer (1933) suggests that they belong to the same taxa. However, the taxonomic relationship between the two species is not yet well defined (Kreisel, 1996), a situation that calls for additional

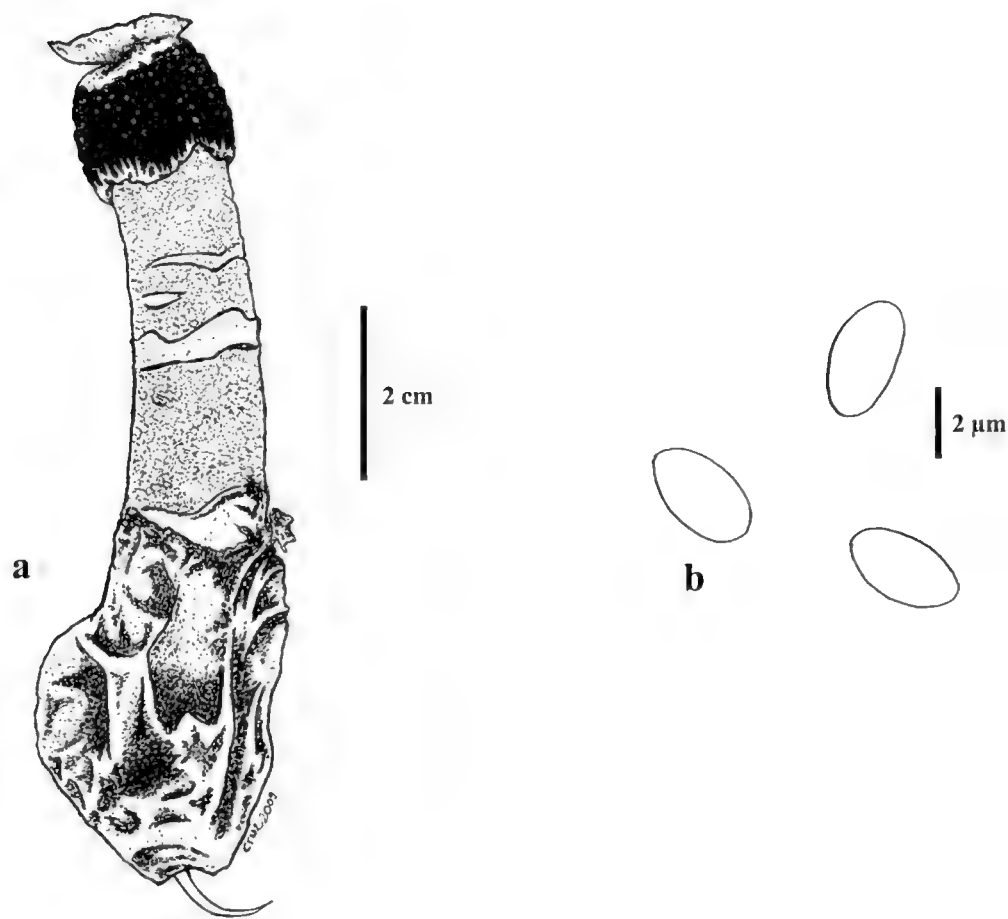


FIG. 1. *Phallus roseus*: a. basidioma; b. basidiospores.

molecular studies on the group. This is the first record of *P. roseus* from the neotropics.

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References

- Baseia IG, Gibertoni TB, Maia IC. 2003. *Phallus pygmaeus*, a new minute species from tropical rain forest. Mycotaxon 85: 77–79.
- Baseia IG, Maia LC, Calonge FD. 2006. Notes on *Phallales* in the Neotropics. Bol. Soc. Micol. Madrid 30: 87–93.
- Calonge FD. 2005. A Tentative key to identify the species of *Phallus*. Bol. Soc. Micol. Madrid 29: 9–17.
- Calonge FD, Kreisel H, Mata M. 2005a. *Phallus atrovolvatus*, a new species from Costa Rica. Bol. Soc. Micol. Madrid 29: 5–8.

- Calonge FD, Mata M, Carranza J. 2005b. Contribución al catálogo de los gasteromycetes (*Basidiomycotina*, *Fungi*) de Costa Rica. Anal. del Jard. Bot. Madrid 62: 23–45.
- Dring DM. 1964. Gasteromycetes of West Tropical Africa. Mycological Papers 98: 1–60.
- Fischer E. 1933. Reihe *Gasteromyceteae*. In Engler A, und Prantl K. (ed.), Die natürlichen Pflanzenfamilien, Band 7. Leipzig. 122pp.
- Kirk MP, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi. 10th ed. CAB Europe. 771 pp.
- Kornerup A, Wanscher JE. 1978. Methuen Handbook of Colour, 3th edn. London Methuen. 243 pp.
- Kreisel H. 1996. A preliminary survey of the genus *Phallus* sensu lato. Czech Mycol. 48: 273–281.
- Kreisel H, Al-Fatimi M. 2008. Further Basidiomycetes from Yemen. Feddes Repertorium 119: 463–483.
- Miller OK Jr, Miller HH. 1988. Gasteromycetes: morphology and developmental features. Mad River, Eureka, CA. 157pp.
- Mornand J. 1986. Les gastéromycètes de France. II. Documents Mycologiques 17(65): 1–18, 1986.
- Rocabado D, Wright JE, Maillard OZ, Muchenik NF. 2007. Catálogo de los gasteromycetes (*Fungi*: *Basidiomycotina*) de Bolivia. Kempffiana 3: 3–13.
- Trierveiler-Pereira LP, Loguercio-Leite C, Calonge FD, Baseia IG. 2009. An emendation of *Phallus glutinolens*. Mycol. Progress 8: 377–380.
- Velloso AL, Sampaio EVSB, Pareyn FGC. 2002. Ecorregiões propostas para o Bioma Caatinga. PNE- Associação plantas do Nordeste, Instituto de Conservação Ambiental, Nature Conservancy do Brasil, 76pp.

***Tephromela follmannii* (lichenized Ascomycota), a new species from the Canary Islands**

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Abstract—*Tephromela follmannii*, found on basaltic rocks on the Canary Islands, is described as new to science. A description of the species is provided, together with notes on its chemistry, distribution, ecology, and taxonomy. Possible related taxa are discussed briefly.

Key words—biodiversity, Macaronesia

Introduction

The Canary Islands form part of Macaronesia, one of the world's biodiversity hotspots (Myers et al. 2000). The diverse lichen flora of the islands has more than 1500 species in an area of just 7447 km² (Hafellner 1995, 1999, 2002, 2005, 2008), and new species are still being discovered at frequent intervals (e.g. Elix & Schumm 2003, van den Boom & Vězda 2005, Pérez-Vargas et al. 2007, 2010a,b, Pérez-Vargas & Pérez de Paz 2009). In the present work we describe a new species of *Tephromela*.

The lichen genus *Tephromela* M. Choisy was resurrected by Hafellner to accommodate several species previously assigned to *Lecanora* (the *L. atra* s.l. complex), primarily on the basis of ascus structure, and placed in a new family, *Tephromelataceae*, within the *Lecanorales* (Hafellner 1984). However, the familial affiliation of this genus is unresolved, as recent molecular studies were inconclusive in deciding whether *Tephromela* should be included in the *Tephromelataceae* or assigned to the *Mycoblastaceae* (Miadlikowska et al. 2006, Arup et al. 2007). The genus includes approximately 40 species with arctic/alpine and temperate distributions in Australasia, Asia, Europe and

North America, and centers of speciation in tropical regions (Nash et al. 2004). *Tephromela follmannii* is closely related to the type species, *T. atra* (Huds.) Hafellner. However, the genus has not been monographed and some European morphotypes of *T. atra* remain poorly understood, as is the delimitation of *T. atra* from some extra-European species (Hafellner 2007). The lecideoid species were recently transferred to *Calvitimela* Hafellner on the basis of the ascomata and ascus type (Hafellner & Türk 2001). *Tephromela* is characterized by a poorly developed true exciple, the dark violaceous hymenium, *Bacidia*-type asci, simple or sparingly branched paraphyses and the occurrence of moniliform conidiogenous cells (Hafellner 1984, Nash et al. 2004).

Materials and methods

The morphology of the lichen specimens was examined using a Leica ZOOM 2000 or a Zeiss Stemi 2000C stereo-microscope. Sections for anatomical examination were cut by hand and mounted and observed in water. Anatomical structure and hymenial characters were studied with an Olympus CH light microscope. Chemical constituents were identified by thin layer chromatography using solvent systems A [benzene:dioxane:acetic acid, 180:45:5], B [hexane:methyl *tert.*-butyl ether:formic acid, 140:72:18] and C [toluene:acetic acid, 85:15] (Culberson 1972, Culberson & Johnson 1982, Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples. Specimens are deposited in TFC and CANB.

The species

Tephromela follmannii Pérez-Vargas, Hern.-Padr. & Elix, sp. nov.

FIG. 1

MYCOBANK MB 515344

Tephromelae atrae similis sed thallo crassiore, hymenium profundis et materia chimica differt. Thallus saxicola, albidus vel cremeus, 0.8–1.2 mm crassus. Apothecia usque ad 2(–3) mm in diametro, sessilia, margine thallino circumdata. Hymenium 150–180(–200) µm altum, violaceum. Asci clavati 60–65 × 10–15 µm, typum Bacidia. Ascosporae octonae, ellipsoideae, 10–11 × 6–7 µm. Materia chimica: atranorinum, acidum β-alectoronicum, acidum alectoronicum, acidum α-collatolicum, acidum β-collatolicum, acidum physodicum, acidum 4-O-methylphysodicum et substantia ignota.

TYPE— Spain, Canary Islands, Tenerife, “Tiro del Guanche”, El Teide National Park, on basaltic rocks, UTM: 334317/ 3122460, 2050 m alt., August 2006, C. Hernández & P. L. Pérez, TFC Lich: 6219 (TFC Lich-**holotype**, CANB-isotype).

ETYMOLOGY— The new species is named in honour of the German lichenologist, Prof. Dr. Gerhard Follmann, in recognition of his many contributions to Canarian lichenology and for his friendship.

Thallus saxicolous, areolate-bullate to verrucose, whitish to cream-coloured, 0.8–1.2 mm thick, lacking isidia and soredia. Cortex 15–25 µm thick, algal layer c. 40–60 µm thick; algal cells 10–12 µm wide; medulla white. Apothecia common, sessile, up to 2(–3) mm wide; disc concave or plane to slightly convex,



FIG. 1. *Tephromela follmannii*, part of holotype. Scale = 1 mm.

round, black, glossy and epruinose; thalline exciple prominent, persistent, smooth to folded over the disc, 180–225 μm wide; true exciple not apparent. Epihymenium dark violet; hymenium 150–180(–200) μm high, violet, I+ blue; subhymenium hyaline, 25–30 μm thick, hypothecium yellow-brown, 75–100 μm thick. Paraphyses stout, not or sparingly branched, mostly not anastomosing, 5–6 μm thick below (lumina c. 2 μm wide), 8–9 μm thick apically (lumina c. 3.5 μm wide). Asci of *Bacidia*-type, 8-spored, 60–65 \times 10–15 μm . Ascospores ellipsoid, colourless, 10–11 \times 6–7 μm . Pycnidia not seen.

CHEMISTRY— Atranorin (minor), β -alecoronic acid (minor or major), alecoronic acid (major or minor), α -collatolic acid (minor), β -collatolic acid (minor), physodic acid (trace), 4-O-methylphysodic acid (trace), unknown (minor).

ECOLOGY— *Tephromela follmannii* occurs on basaltic rocks on four of the Canary Islands. It exhibits considerable ecological plasticity but it appears to prefer moderate to high elevations. On Tenerife it was collected in the mountains of Teide National Park at 1900–2050 m, in “retamar”, a montane shrub-dominated community. Phytosociologically this community belongs to *Spartocytisetum supranubii* Oberd. ex Esteve (Martín Osorio et al. 2007), with *Spartocytisus supranubius*, *Pterocephalus lasiospermus* and pine (*Pinus*

canariensis) reafforestation. On La Palma *T. follmannii* grows at 550–2450 m in a *Pinus canariensis* forest (*Loto hillebrandii*-*Pinetum canariensis*, A. Santos) or in the high mountain in “codesar” (*Genisto benehoavensis*-*Adenocarpetus spartioidis* A. Santos (Del Arco Aguilar 2006)), with *Adenocarpus viscosus* subsp. *spartioides*, *Genista benehoavensis* and sporadically *Spartocytisus supranubius*, *Descurainia gilva*, or *Viola palmensis*. We have also collected this species on Gran Canaria at over 1000 m in a *Pinus canariensis* forest. Finally, on La Gomera *T. follmannii* was collected at 1100–1200 m alt., in an old pine plantation (*Pinus canariensis* and *P. radiata*) with *Erica arborea*, *Adenocarpus foliolosus*, *Chamaecytisus proliferus* and *Cistus* spp.

ADDITIONAL SPECIMENS EXAMINED— SPAIN, CANARY ISLANDS, TENERIFE: “El Boquete”, El Teide National Park, on basaltic rocks, UTM: 335005/3121230, 2100 m alt., February 2006, C. Hernández & P. L. Pérez, TFC Lich: 6510 (duplicate in CANB); “Los Areneros”, El Teide National Park, on basaltic rocks, UTM: 335330/3131162, 1900 m alt., August 2007, C. Hernández & P.L. Pérez, TFC Lich: 9025; LA PALMA: “Inmediaciones del Pico de Piedra Llana”, Caldera de Taburiente National Park, on basaltic rocks, UTM: 222792/ 319279, 2320 m alt., November 2001, C. Hernández & P.L. Pérez, TFC Lich: 5311 (duplicate in CANB); “Cauce del barranco del Huanahuao”, Caldera de Taburiente National Park, on basaltic rocks, UTM: 219650/ 317899, 550 m alt., January 2001, E. Muñoz & A. Rebolé, TFC Lich: 3345; GRAN CANARIA: “Camino de Faneque, ca. Tamadaba”, Pinar de Tamadaba, on basaltic rocks, 1000 m alt., April 1976, B. Méndez, TFC Lich: 118; LA GOMERA: “Laderas sobre Erquito”, Garajonay National Park, on basaltic rocks, UTM: 277609/3111281, 1125 m alt., September, 2001, C. Hernández & P.L. Pérez, TFC Lich: 5035 (duplicate in CANB).

Discussion

The saxicolous *T. follmannii* is characterized by its thick, greyish cream, areolate-bullate to verrucose thallus, large, black apothecia, a thick hymenium, and by its complex chemistry.

This new species appears to be closely related to *T. atra*, and while it can resemble some well-developed saxicolous specimens of that species, it can be distinguished by the thicker verrucose thallus (0.8–1.2 mm vs. 0.3–0.5 mm thick), the thicker hymenium (150–200 µm vs. 50–60 µm), and more complex chemistry.

Morphologically, *T. follmannii* resembles the Australian *T. stenoporonica* Elix & Kalb, but the latter has a different chemistry, with the substitution of stenoporonic and colensoic acids for the depsidones present in most species of this group (α-collatolic and alectoronic acids). In addition, *T. stenoporonica* has white pruina along ridges and margins of the areolae (Elix & Kalb 2006).

Tephromela priestleyi (C.W. Dodge) Øvstedal, from Antarctica, has a similar hymenium, asci, and ascospores to *T. follmannii*, but it has a squamulose-placodioid thallus, larger apothecia (up to 3.5 mm wide), and simple chemistry (containing only atranorin) (Øvstedal & Lewis Smith 2009).

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Literature cited

- Arup U, Ekman S, Grube M, Mattsson JE, Wedin M. 2007. The sister group relation of *Parmeliaceae* (*Lecanorales*, *Ascomycota*). *Mycologia* 99: 42–49.
- Boom P van den, Vězda A. 2005. *Gyalecta canariensis* sp. nov., a new lichen (*Ascomycota*) described from La Palma (Canary Islands). *Mycotaxon* 92: 255–258.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Culberson CF, Johnson A. 1982. Substitution of methyl tert.-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *Journal of Chromatography* 238: 483–487.
- Del Arco Aguilar MJ. (ed.) 2006. Mapa de vegetación de Canarias. Grafcan. Santa Cruz de Tenerife.
- Elix JA, Ernst-Russell KD. 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances, 2nd edn. Canberra: Australian National University.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Elix JA, Schumm F. 2003. New species and new records in the lichen family *Parmeliaceae* (*Ascomycota*) from Macaronesia. *Mycotaxon* 86: 383–388.
- Elix JA, Kalb K. 2006. Two new species of *Tephromela* (*Lecanoraceae*, lichenized *Ascomycota*) from Australia. *Australasian Lichenology* 58: 27–31.
- Hafellner J. 1984. Studien in Richtung einer natürlichen Gliederung der Sammelfamilien *Lecanoraceae* und *Lecideaceae*. Beiheft zur Nova Hedwigia 79: 241–371.
- Hafellner J. 1995. A new checklist of lichens and lichenicolous fungi of insular Laurimacaronesia including a lichenological bibliography for the area. *Fritschiana* 5: 1–135.
- Hafellner J. 1999. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. I. *Fritschiana* 17: 1–26.
- Hafellner J. 2002. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. II. *Fritschiana* 36: 1–10.
- Hafellner J. 2005. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. III. *Fritschiana* 50: 1–13.
- Hafellner J. 2007. The lichenicolous fungi inhabiting *Tephromela* species. *Bibliotheca Lichenologica* 96: 103–128.
- Hafellner J. 2008. Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of insular Laurimacaronesia. IV. *Fritschiana* 64: 1–28.
- Hafellner J, Türk R. 2001. Die lichenisierten Pilze Österreichs-eine Checkliste der bisher nachgewiesenen Arten mit verbreitungsangaben. *Stapfia* 76: 1–167.
- Martín Osorio VE, Wildpret de la Torre W, del Arco Aguilar M, Pérez de Paz PL, Hernández Bolaños B, Rodríguez O, Acebes JR, García Gallo A. 2007. Estudio bioclimático y fitocenótico comparativo de la alta cumbre canaria: Tenerife–La Palma. Islas Canarias. *Phytocoenologia*

37: 663–697.

- Miadlikowska J, Kauff F, Hofstetter V, Fraker E, Grube M, Hafellner J, Reeb V, Hodkinson BP, Kukwa M, Lücking R, Hestmark G, Garcia Ojalora M, Rauhut A, Büdel B, Scheidegger C, Timdal E, Stenroos S, Brodo I, Perlmutter GB, Ertz D, Diederich P, Lendemer JC, May P, Schoch CL, Arnold AE, Gueidan C, Tripp E, Yahr R, Robertson C, Lutzoni F. 2006. New insights into classification and evolution of the Lecanoromycetes (Pezizomycotina, *Ascomycota*) from phylogenetic analyses of three ribosomal RNA- and two protein-coding genes. *Mycologia* 98: 1088–1103.
- Myers N, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Kent J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853–858.
- Nash TH, Kalb K, Rambold G. 2004. *Tephromela*. 530–532, in BD Ryan et al. (eds), Lichen flora of the greater Sonoran Desert region. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- Øvstedal DO, Lewis Smith RI. 2009. Further additions to the lichen flora of Antarctica and South Georgia. *Nova Hedwigia* 88: 157–168.
- Pérez-Vargas I, Hernández-Padrón C, Elix JA. 2007. A new species of *Xanthoparmelia* (*Ascomycota*: *Parmeliaceae*) from the Canary Islands. *Lichenologist* 39: 445–449.
- Pérez-Vargas I, Pérez de Paz PL. 2009. *Caloplaca chelyae*, (*Teloschistaceae*) a new lichen from the Canary Islands. *Bryologist* 112: 840–845.
- Pérez-Vargas I, Hernández-Padrón C, Pérez de Paz PL, Elix JA. 2010a. *Xanthoparmelia teydea*, a new brown *Xanthoparmelia* (*Parmeliaceae*) from the Canary Islands. *Bryologist* 113: 51–54.
- Pérez-Vargas I, Hernández-Padrón C, Etayo J, Pérez de Paz PL, Elix JA. 2010b. New species of *Pertusaria* (Lichenized *Ascomycota*: *Pertusariaceae*) from the Canary Islands. *Lichenologist* 42: 35–41.

Two new species of *Graphidaceae* (lichenized *Ascomycota*) from Brazil

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Abstract – *Phaeographis flavescens* and *Thalloloma pontalense* are described as new species. These species were found growing in restinga in Southern Brazil.

Key words – lichenized fungi, lichens, *Ostropales*, Paraná

Introduction

The family *Graphidaceae* Dumort. contains about 1000 species and is an important component of the lichen biota in tropical and subtropical regions (Staiger et al. 2006). During a survey of *Graphidaceae* in Paraná State, Southern Brazil, one new species of *Phaeographis* and one new species of *Thalloloma*, both with stictic acid, were encountered.

Phaeographis Müll. Arg. is a genus characterized by brown ascospores reacting I+ wine-red, generally inspersed hymenia, poorly developed and uncarbonized excipula and lirellae with exposed discs (Staiger 2002, Archer 2006, Cáceres 2007, Lücking & Rivas-Plata 2008).

Thalloloma Trevis. is characterized mainly by the ecorticate thallus and lirellae with brown or red exposed discs, hyaline ascospores reacting I+ violet, uncarbonized excipula and clear hymenia (Staiger 2002, Archer 2006, Cáceres 2007, Lücking & Rivas-Plata 2008).

The new species are described and illustrated below.

Materials and methods

The new species were described from specimens collected in a typical Brazilian coastal vegetation forest, known as restinga, in Paraná State, Southern Brazil. The

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specimens were examined using standard stereoscopic and light microscopic techniques. Sections of thalli and ascomata were mounted in water, 10% KOH and Lugol's Solution. All measurements were made in water. Chemical constituents were identified by thin layer chromatography (Culberson & Ammann 1979, Elix & Ernst-Russell 1993) and by comparison with authentic samples.

Taxonomy

Phaeographis flavescens Dal-Forno & Eliasaro, sp. nov.

FIG. 1

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Simile Phaeographis intricans sed acidum sticticum continente differt.

TYPE: BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'11.1" W48°21'32.4", M. Dal-Forno 433 (HOLOTYPE-UPCB).

ETYMOLOGY: The specific epithet is derived from the Latin *flavus*, and it refers to the yellow color of the thallus after the application of potassium hydroxide solution.

Thallus corticolous, epiperidermal, continuous, 130–140 µm thick, with crystals; surface green to yellowish green, dull, smooth; corticate. Ascomata lirelliform, immersed in pseudostromata, flexuose, branched, 0.3–2.0 mm long, 0.2–0.3 mm wide, with small lateral cracks; disc exposed, grey with white pruina; pseudostromata conspicuous, pale yellow, distinctly raised from the thallus, 150–200 µm high, with crystals; labia entire; excipulum uncarbonized, 85–125 µm high, laterally rudimentary, base well developed, yellow, 25 µm high. Hymenium clear, 60–100 µm high, 125–175 µm wide, I–; paraphyses unbranched but with branched tips, filiform, 1.0–1.5 µm thick, hyaline, with brown tips; ascospores 8 per ascus, brown, I+ wine-red, ellipsoid, transversely (3–)5-septate, 21–25 × 6–7 µm.

CHEMISTRY: thallus K+ yellow, stictic acid and other stictic acid satellites present.

ADDITIONAL SPECIMENS EXAMINED – BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'11.1" W48°21'32.4" M. Dal-Forno 336, 346, 371, 377 (UPCB).

COMMENTS – *Phaeographis flavescens* is characterized by immersed lirellae in a pale yellow prominent pseudostroma, with greyish white pruinose discs, an uncarbonized excipulum, a clear hymenium, brown, small and transversely 5-septate ascospores, and the presence of stictic acid and other related compounds.

This species is very similar to species in *Sarcographa* Fée, suggested by the formation of well defined stromatic clusters, conspicuously raised from the thallus, and by the chemistry. In addition, *Phaeographis flavescens* possesses small slits in the margins of the lirellae, which could be confused with the characteristic transverse fissures of *Sarcographa*. Despite these characteristics,



FIGURES 1–2: New species of *Graphidaceae* from Brazil. 1: *Phaeographis flavescens* (holotype, UPCB); 2: *Thalloloma pontalense* (holotype, UPCB); bars = 1 mm.

the brown ascospores reacting I+ wine-red, lirellae with exposed discs and the clear hymenia place the new species in the genus *Phaeographis*. The absence of carbonization in the exciple excludes the possibility of the new species being a species of *Sarcographa* or other related genus.

Sarcographa cuyabensis Redinger is very similar to *P. flavescens*, differing by the slightly smaller ascospores, (12–)15–18 µm long, and the indistinct pseudostroma (Redinger 1933).

Phaeographis intricans (Nyl.) Staiger closely resembles *P. flavescens*, differing only in the lichen compounds present: norstictic acid in *P. intricans* (Nylander 1863, Staiger 2002) and stictic acid and related compounds in *P. flavescens*.

***Thalloloma pontalense* Dal-Forno & Eliasaro, sp. nov.**

FIG. 2

MYCOBANK 513535

Simile *Thalloloma anguinum* sed *lirellas latiores et acidum sticticum continente differt*.

TYPE: BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'02.2" W48°22'01.8", M. Dal-Forno 592 (HOLOTYPE-UPCB).

ETYMOLOGY: The specific epithet is derived from the type locality, Pontal do Sul, Southern Brazil.

Thallus corticolous, epiperidermal, continuous, 40–70 µm high, with crystals; surface whitish pale grey, dull, smooth; corticate. Ascomata lirelliform, flexuose, unbranched to branched, immersed to erumpent, 0.8–1.0 mm long, 0.3–0.4 mm wide; discs exposed, pale brown pruinose; thalline margin laterally present, conspicuous, 200–225 µm high, 45–50 µm thick, extending beyond the hymenium and excipulum; labia entire; excipulum uncarbonized, 75–100 µm high, rudimentary. Hymenium clear, 75–100 µm high, 220–230 µm wide, I–; paraphyses branched and anastomosing, filiform, 1.0 µm thick, hyaline, with brown tips; ascospores 8 per ascus, hyaline to slightly brownish, I+ violet-blue, ellipsoid, muriform, 11–13 × 3–4-locular, 45–55 × 14–15 µm.

CHEMISTRY: thallus K+ yellow, stictic acid present.

ADDITIONAL SPECIMENS EXAMINED – BRAZIL. PARANÁ: Pontal do Paraná. PONTAL DO SUL, 28.II.2008, S25°34'02.2" W48°22'01.8" M. Dal-Forno 581 (UPCB).

COMMENTS – *Thalloloma pontalense* is characterized by the oblong to slightly elongated ascomata, not showing the typical shape of a lirella, with exposed, brown pruinose discs, muriform ascospores with 40–50 µm and presence of stictic acid.

Stictic acid is one of the most common lichen compounds found in the *Graphidaceae* (Staiger 2002) but it is uncommon in the genus *Thalloloma*. It occurs in *T. patulum* (A.W. Archer) A.W. Archer from the Solomon Islands (Archer 2007).

Thalloloma pontalense is very similar to *T. anguinum* (Mont.) Trevis., but differs in the shape of the lirellae, which are not very elongated, the presence of stictic acid, and the absence of lichexanthone. *Thalloloma pontalense* also has much wider ascomata, being 0.3–0.4 mm wide, whereas *T. anguinum* has lirellae 0.15–0.2 mm wide, exactly half the width, which in *Graphidaceae* is a significant difference. In addition, *Thalloloma pontalense* has a conspicuous thalline margin, extending 100 µm above the hymenium, whereas the thalline margin in *T. anguinum* is only present laterally, not extending beyond the level of the hymenium and excipulum.

Thalloloma pontalense is morphologically similar to a species found in Costa Rica, namely “*Thalloloma chroodiscoides*” (Sipman 2008). However, the later species has smaller ascospores, up to 26 µm long, and it lacks lichen compounds.

Thalloloma deplanatum (Nyl.) Staiger is also similar to *T. pontalense*, showing the same shape of ascomata and size of ascospores, but in *T. deplanatum* the thalline margin is less conspicuous, the excipulum has a double margin and the ascospores have only transverse septa.

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Literature cited

- Archer AW. 2006. The Lichen Family *Graphidaceae* in Australia. *Bibliotheca Lichenologica* 94: 1–191.
- Archer AW. 2007. Key and checklist for the lichen family *Graphidaceae* (lichenised *Ascomycota*) in the Solomon Islands. *Syst. biodivers.* 5: 9–22.
- Cáceres MES. 2007. Corticolous crustose and microfoliose lichens of northeastern Brazil. *Libri Botanici* 22: 1–168.
- Culberson CF, Ammann K. 1979. Standardmethode zur Dünnschichtchromatographie von Flechtensubstanzen. *Herzogia* 5: 1–24.
- Elix JA, Ernst-Russell KD. 1993. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances. 2nd ed. Australian National University Canberra.
- Lücking R, Rivas-Plata E. 2008. Clave y Guía Ilustrada Para Géneros de *Graphidaceae*. *Glalia* 1: 1–41.
- Nylander, W. 1863. *Lichenographiae Novo-Granatensis Prodomus*. *Acta Societatis Scientiarum Fennicae* 7: 415–504.
- Redinger K. 1933. Die Graphidineen der ersten Regnell'schen Expedition nach Brasilien 1892–94. I. Glyphis, Medusulina und Sarcographa. *Arkiv for Botanik* 25A(13): 1–21.

- Staiger B. 2002. Die Flechtenfamilie *Graphidaceae*: Studien in Richtung einer natürlicheren Gliederung. *Bibliotheca Lichenologica* 85: 1–526.
- Staiger B, Kalb K, Grube M. 2006. Phylogeny and phenotypic variation in the lichen family *Graphidaceae* (*Ostropomycetidae*, *Ascomycota*). *Mycological Research* 110: 765–772.
- Sipman, H. 2008. Provisional determination keys for the *Graphidales* of Costa Rica. Ticolichen Project. Chicago, The Field Museum [<http://www.bgbm.org/BGBM/STAFF/Wiss/Sipman/Zschackia/Diorygma/Thalloloma.htm#Thalloloma> (viewed online on 18 September 2008)].

A new species of *Phlebia* (Basidiomycetes) from India

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Abstract – A new corticioid species *Phlebia crassisubiculata* is described from Dalhousie hills (District Chamba) in Himachal Pradesh, India.

Key words – Banikhet, thick subiculum, large spores

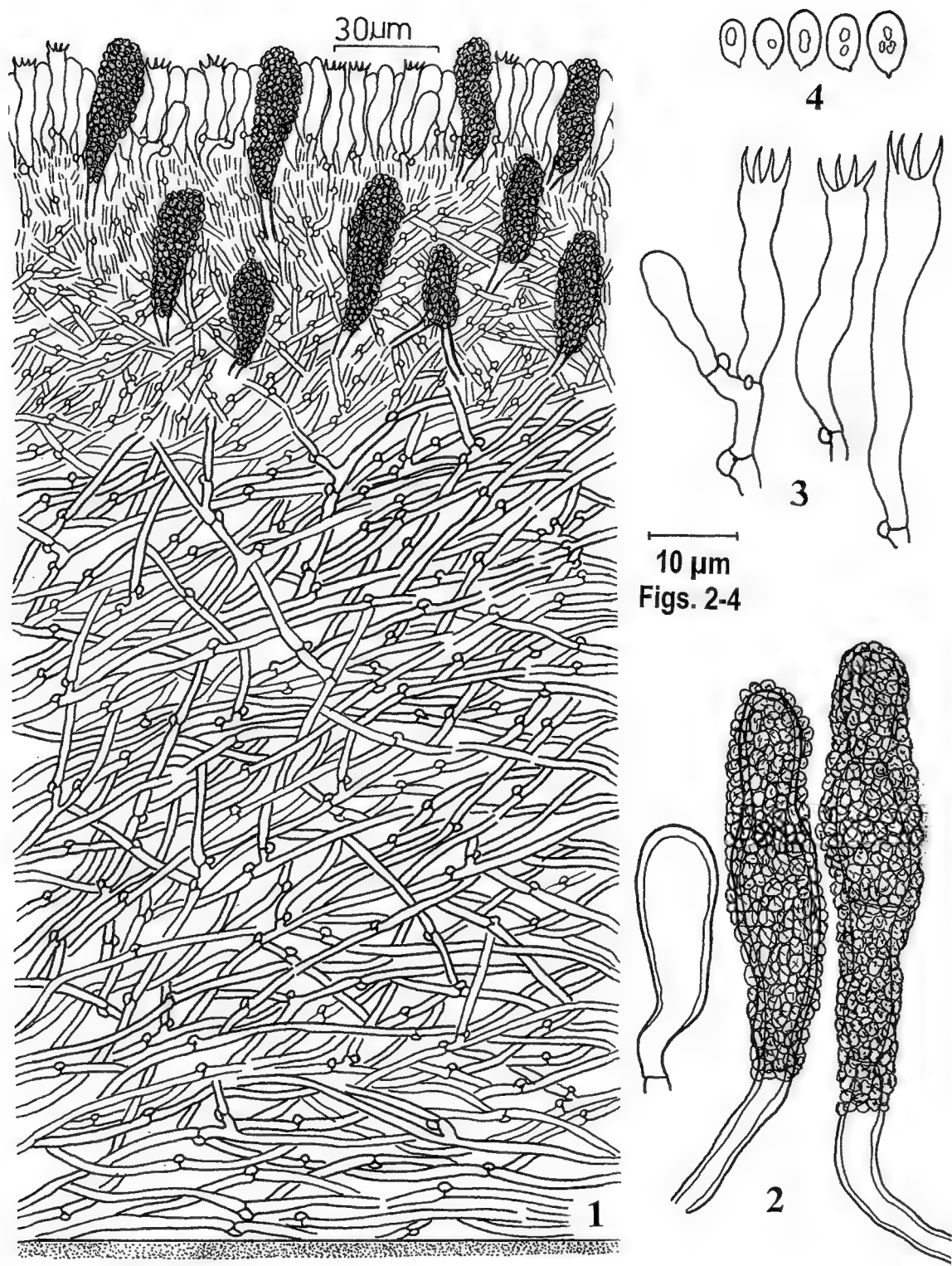
During a mycological excursion in Dalhousie hills (Himachal Pradesh, India), Dhingra and Singla made a collection on the underside of a decaying gymnospermous stump. After detailed comparison of macroscopic and microscopic features with relevant literature (Dhingra 2005, Eriksson et al. 1981, Larsson & Hjortstam 1977, Parmasto 1968, Rattan 1977), it was found to be close to *Phlebia cremeoalutacea* (Parmasto) K.H. Larss. & Hjortstam. Characters in common were thick-walled encrusted cystidia and subclavate to clavate basidia. However, the subiculum in the newly described species was distinctly the thick compared with the thin subiculum in *Phlebia cremeoalutacea* and basidiospores were larger ($5.1\text{--}6.8 \times 2.8\text{--}4.5 \mu\text{m}$) than those in the latter species ($3.0\text{--}4.5 \times 2.0\text{--}2.5 \mu\text{m}$). A sample of the basidiocarp was sent to Prof. Nils Hallenberg, University of Gothenburg, Sweden, who supported the concept of a new species.

Phlebia crassisubiculata Avneet P. Singh, Priyanka, Dhingra & Singla, sp. nov.

MYCOBANK 515886

FIGS 1–5

Basidiocarpum resupinatum, adnatum, effusum, ad 350 μm crassum; hymenium superficiei laevigatum vel subtiliter pubescens, cremeum flavum, infuscatum in 3% KOH; systema hyphale monomiticum; hyphae ad 4 μm latae, ramosae, nodoso-septatae, tenuitunicatae vel paulo crassitunicatae; subiculum crassum, cum hyphis horizontalis; subhymenium augustum, de hyphis verticalis; cystidia 23–80 \times 6.8–10.2 μm , subcylindrica vel subfusiformia, encrustata; basidia 23–40.3 \times 5.1–6.2 μm , subclavata vel clavata, 4-



FIGS 1–4. Microscopic structures from basidiocarp of *Phlebia crassisubiculata*.
1. Section of basidiocarp; 2. cystidia; 3. basidia; 4. basidiospores.

sterigmata, ad basin fibuligera; basidisporae 5.1–6.8 × 2.8–4.5 μm, *ellipsoidae, laeves, tenuitunicatae, multiguttatae*.

TYPE: India, Himachal Pradesh: Chamba, 2 km from Dalhousie in direction to Banikhet, on decayed gymnosperm wood, Nishi 1405 (PUN, **holotype**), September 19, 1989.

ETYMOLOGY: Conspicuously thick subiculum.

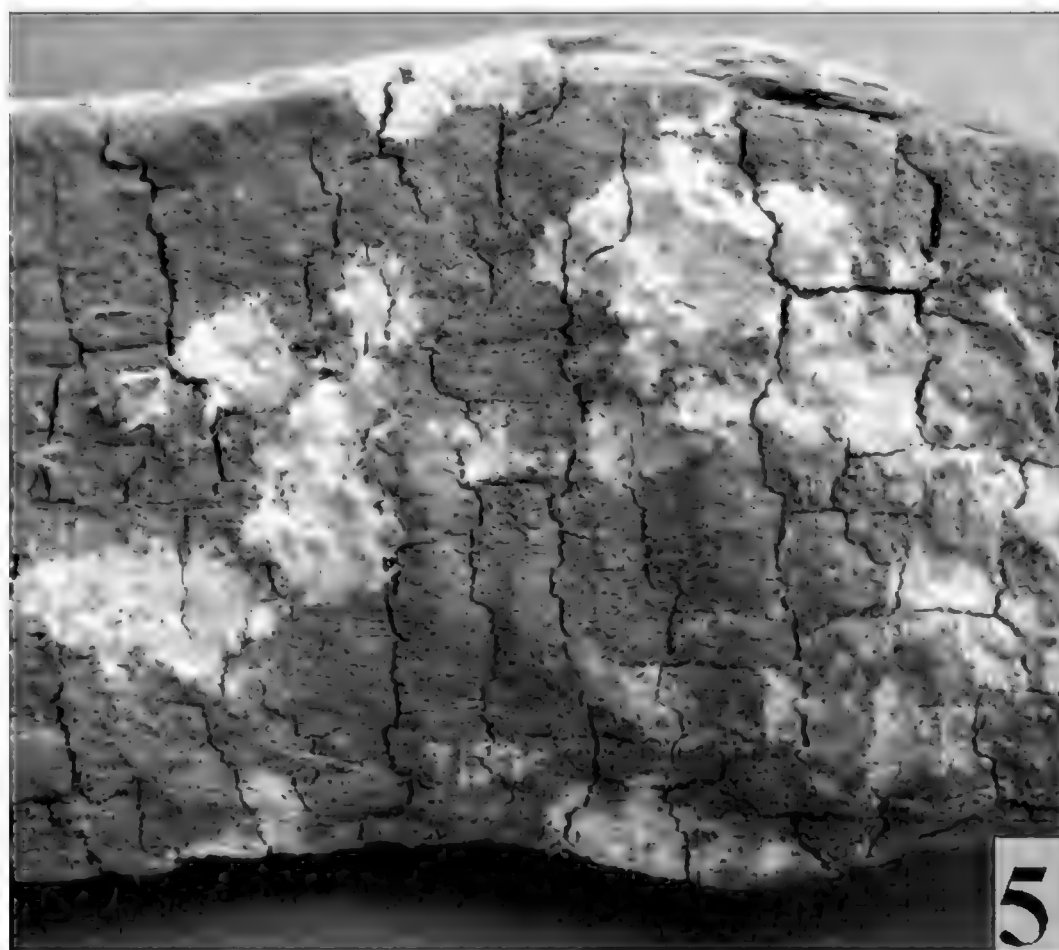


FIG. 5. *Phlebia crassisubiculata* basidiocarp.

Basidiocarps resupinate, arising as small colonies which may coalesce later on and become effused, adnate, up to 350 μm thick in section; hymenial surface smooth to finely pubescent under lens due to projecting cystidia, creamy yellow, darkening in 3% KOH; margins abrupt or indeterminately thinning, paler concolorous. Hyphal system monomitic; generative hyphae up to 4 μm wide, branched, septate, clamped, thin- to somewhat thick-walled; subicular zone very thick, of well developed horizontal hyphae running parallel to the substrate, followed by a narrow subhymenial zone of densely packed, vertical hyphae. Cystidia 23–80 \times 6.8–10.2 μm , subcylindrical to subfusiform, encrusted with encrustation dissolving in 10% KOH, thick-walled, enclosed to somewhat projecting, pseudo-septa may be present. Basidia 23–40.3 \times 5.1–6.2 μm , subclavate to clavate, thin- to somewhat thick-walled, 4-sterigmate, with a basal clamp; sterigmata up to 5.1 μm long. Basidiospores 5.1–6.8 \times 2.8–4.5 μm , ellipsoid, smooth, thin-walled, inamyloid, acyanophilous, with oil droplets.

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Literature cited

- Dhingra GS. 1989. Genus *Phlebia* Fr. in the Eastern Himalaya. J. Ind. Bot. Soc. 84: 111–117.
- Eriksson J, Hjortstam K, Ryvarden L. 1981. The *Corticiaceae* of North Europe – VI. Oslo: 1051–1276.
- Hjortstam K, Larsson KH. 1977. Notes on *Corticiaceae* (*Basidiomycetes*). Mycotaxon 5(2): 475–480.
- Parmasto E. 1968. Conspectus Systematis Corticiacearum. Tartu. 262 pp.
- Rattan SS. 1977. The Resupinate *Aphylllophorales* of the North Western Himalayas. Bibliotheca Mycologica 60: 1–427.

***Volvariella acystidiata* (Agaricomycetes, Pluteaceae),
an African species new to Europe,
with two new combinations in *Volvariella***

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Abstract — *Volvariella acystidiata*, an African species belonging to the *V. gloiocephala*-complex, is firstly reported from Europe on the basis of a collection made in northern Sardinia. This species is easily recognized by its medium size, white overall colour, large, ellipsoid to ovoid basidiospores and the lack of cystidia of any kind. The study includes a description, a photograph of fresh basidiomes and line drawings of relevant micro-anatomic traits.

Key words — *Basidiomycota*, *Agaricales*, taxonomy, biodiversity

Introduction

During a field mycological study of a grassy, anthropically disturbed, coastal site near Golfo Aranci (northern Sardinia), basidiomes of a small, white *Volvariella* resembling the very common *V. gloiocephala* (DC.) Boekhout & Enderle 1986, were collected. They grew on graminaceous debris at the edge of an internal road of the Residence “L’ Eucalyptus” in the La Marinella gulf. After a careful study of the macro- and microscopic features we concluded that they were to be ascribed to *V. acystidiata*, a central-African species of the *V. gloiocephala*-complex thus far known only from Zaire (Heinemann 1975, Pathak 1975). The aim of the paper is to provide a full description of this rare and little known species.

Materials and methods

The description of macro- and microscopical features is drawn from notes taken on fresh material. Microscopical observations were made from material mounted in distilled water, Melzer’s reagent, and Congo red. Spore size is expressed both as a range and mean

* corresponding author

value based on 30 randomly chosen spores. Author citations follow the IPNI Authors and Index Fungorum Authors of Fungal Names websites. Herbarium abbreviations are according to Holmgren & Holmgren (1998). All examined material is housed at TO (Herbarium generale del Dipartimento di Biologia Vegetale, Università degli Studi di Torino, Italy).

The new combinations were deposited in MycoBank.

Taxonomy

Volvariella acystidiata N.C. Pathak, Bull. Jard. Bot. Natl. Belg. 45: 195 (1975).

FIGS. 1-2

PILEUS 20–30 mm broad, not very fleshy, convex expanding to plano-convex, slightly (obtusely) umbonate, glabrous, without patches from the universal veil, slightly sticky, but very soon dry and shiny, short-striate on the margin (up to 10 mm), white, tinged yellowish near the centre and pale pink towards the margin. LAMELLAE close to moderately close, broad, ventricose, free to rotundate, pale pink then salmon-pink, with uneven edges. STIPE 30–40 × 2–3 mm, central, not solid, stuffed then hollow, subequal or slightly enlarged downwards, but not really bulbous, glabrous, sericeous, white, dry. Volva saccate, but narrow and shallow, sheathing only the stipe base, thin, white, non-lobed. CONTEXT moderately thick in the centre of the pileus, thin towards the margin, soft, white, unchanging. Smell faint, raphanoid. Taste similar. SPORE-PRINT salmon-pink.

BASIDIOSPORES 10.5–16.5 × 7.5–10.5 µm, on average 14.5 × 10 µm, Q = 1.4–1.6, pale pink, ovoid to ellipsoid, thick-walled, with several oil-drops, inamyloid, smooth, with a prominent apiculus (FIG. 2a). BASIDIA 45–70 × 10–13.5 µm, 2–4-spored, clavate (FIG. 2b); sterigmata up to 1.5 µm long; SUBHYMENIUM cellular. HYMENOPHORAL TRAMA inversely bilateral, made up of hyaline, thin-walled, cylindrical hyphae. CHEILO- and PLEUROCYSTIDIA absent. PILEIPELLIS a cutis of variously twisted hyphae, up to 7.5 µm wide, slightly gelatinized in the suprapellis (FIG. 2c). CLAMP-CONNECTIONS absent everywhere. THROMBOPLEROUS HYPHAE not seen.

HABITAT. Firstly recorded from central Africa (Zaire) on dry forest soil and dung; in Sardinia collected among graminaceous debris on sandy, grassy soil, not far from the sea. In autumn and winter.

DISTRIBUTION. Known with certainty only from central Africa (Zaire) and Italy (Sardinia). Probably also present elsewhere, but possibly misidentified as *V. gloiocephala* f. *speciosa*, a very common agaric, generally considered unworthy of study.

MATERIAL STUDIED: ITALY: Sardinia, prov. Olbia-Tempio P., Golfo Aranci, loc. Golfo di Marinella, in grassy, sandy soil, on graminaceous debris (*Poaceae*), 2.XI.2009, leg. A. Vizzini and M. Contu (TO HG1973).



FIGURE 1. *Volvariella acystidiata*. Basidiomes (TO HG1973). Scale bar = 20 mm

Discussion

On describing *Volvariella acystidiata*, Pathak (1975) provided only a very short Latin diagnosis and presented no illustrations of either gross or micro-anatomical features. Shortly thereafter, Heinemann (1975) supplied a more detailed description of the species in French, regrettably based only on the poorly preserved type collection. A colour plate of the species can be found in Heinemann (1975: pl. XIV, fig. 1).

Doubtlessly, *V. acystidiata* belongs to the *V. gloiocephala* complex based on its very large basidiospores and slightly sticky pileus surface, but it is easily separated from the white form of *V. gloiocephala*, viz. f. *speciosa* (Fr.) Contu 1998, by the complete lack of cheilo- and pleurocystidia. We carefully examined all four specimens in our collection for the possible occurrence of even an occasional hymenial sterile element, but we were not able to find any. *V. gloiocephala*, by contrast, shows many large, versiform, clavate, ventricose to subfusiform cystidia, on both face and edge of lamellae (Shaffer 1957 as “*Volvariella speciosa* (Fr.) Sing.”; Orton 1974, 1986; Boekhout 1990; Boekhout & Enderle 1986). Another white species of the *V. gloiocephala* complex, *V. cookei* Contu 1998, also shares an only slightly sticky pileus surface and a white volva, but it is readily distinguished by its conspicuous cystidia, which are clavate with a very long and thin appendage, and the smaller basidiospores (Contu 1998, 2004).

Other white, medium-sized species of *Volvariella* are *V. nivea* T.H. Li & Xiang-L. Chen 2009 (Li et al. 2009), *V. nauseosa* (see below), *V. strangulata* (see below), and *V. pusilla* (Pers.) Singer 1951. However, they are easily distinguished

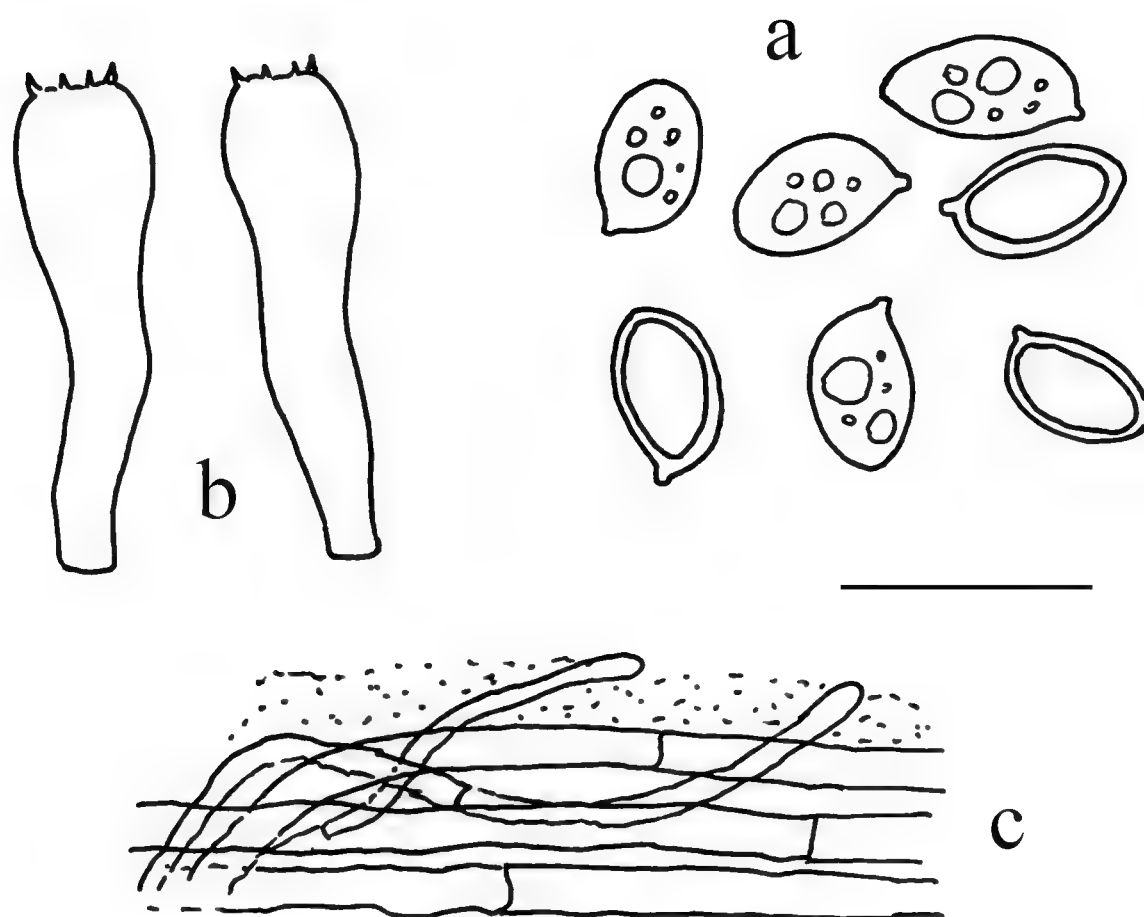


FIGURE 2. *Volvariella acystidiata*. Microscopical features (TO HG1973).
a. Basidiospores. b. Basidia. c. Pileipellis. Scale bar = 20 μ m

especially by the obvious, well-developed cystidia and smaller basidiospores.

The diminutive members of the genus also showing white tinges to the pileus are even more easily separated by their smaller basidiospores and occurrence of cystidia (Shaffer 1957; Orton 1974, 1986; Heinemann 1978; Boekhout 1986, 1990; Boekhout & Enderle 1986).

New combinations in *Volvariella* Speg.

Volvariella nauseosa (Romagn.) Vizzini & Contu, **comb. nov.**

MYCOBANK MB 515695

BASIONYM: *Volvaria nauseosa* Romagn., Rev. Mycol. (Paris) 2: 93 (1937).

This very rare species has been recently collected in Slovenia (mat. in herb. priv. M. Contu). It is distinguished by the mainly fusiform cystidia and a spore size bigger than that of *V. pusilla*; otherwise it is very similar in habit.

Volvariella strangulata (Romagn.) Vizzini & Contu, **comb. nov.**

MYCOBANK MB 515696

BASIONYM: *Volvaria strangulata* Romagn., Bull. trimest.
Soc. Mycol. Fr. 94(4): 371 (1979, "1978").

Moser (2001) published a recent Austrian record of this rather uncommon agaric with a colour photograph depicting fresh basidiomes. M.C. had the chance to study an Italian collection made by Ledo Setti (fragm. in herb. priv. M. Contu) that agrees perfectly with the protologue (Romagnesi 1979).

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Literature cited

- Boekhout T. 1986. Notulae ad Floram Agaricinam Neerlandicam - XII. Small, saprophytic *Volvariella* species in the Netherlands. *Persoonia* 13(2): 197–211.
- Boekhout T. 1990. *Volvariella* Speg. In: Flora Agaricina Neerlandica 2, Bas C, Kuyper ThW, Noordeloos ME, Vellinga EC (eds.), A.A. Balkema, Rotterdam, Brookfield, pp. 56–64.
- Boekhout T, Enderle M. 1986. *Volvariella gloiocephala* (DC: Fr.) Boekhout & Enderle comb. nov. *Beitr Kenn Pilze Mittel II*: 77–79.
- Contu M. 1998. Studi sulle *Pluteaceae* della Sardegna. I. *Volvariella cookei* spec. nov., una nuova specie della sezione *Macrospora*. *Micol Ital* 27(3): 37–41.
- Contu M, Signorello P. 2004. Nuovi dati su *Volvariella cookei* Contu, con chiave per la determinazione delle specie bianche del genere *Volvariella* in Europa. *Bollettino dell'Associazione Micologica ed Ecologica Romana* 59/60: 22–26.
- Heinemann P. 1975. Flore illustrée des champignons d'Afrique central. Fasc. 4. *Volvariella*. Meise.
- Holmgren PK, Holmgren NH. 1998. (continuously updated). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> (accessed 04 Dec. 2009).
- Li TH, Chen XL, Shen YH, Li T. 2009. A white species of *Volvariella* (*Basidiomycota*, *Agaricales*) from southern China. *Mycotaxon* 109: 255–261.
- Moser M. 2001. Beobachtungen zur Gattung *Volvariella*. *Österr Zeitschr Pilzk* 10: 181–184.
- Orton PD. 1974. The European species of *Volvariella* Spegazzini. *Bull Soc Linn Lyon*, n° hors-sér. (trav. Kuhner), pp. 313–326.
- Orton PD. 1986. *Pluteaceae: Pluteus & Volvariella*. British Fungus Flora. Agarics and Boleti. 4. in Henderson DM & al. Ed., Edinburgh.
- Pathak NC. 1975. New species of *Volvariella* from Central Africa. *Bull Jard Bot Natl Belg* 45: 195–196.
- Romagnesi H. 1937. Florule mycologique des bois de la Grange et de l'Etoile (Seine-et-Oise). *Basidiomycetes*. *Rev Mycol (Paris)* 2: 85–95.
- Romagnesi H. 1979 ("1978"). Quelques espèces rares ou nouvelles de Macromycetes. VII. Agarics rhodosporeés (*Volvariaceae*). *Bull Soc mycol France* 94: 371–377.
- Shaffer RL. 1957. *Volvariella* in North America. *Mycologia* 49: 545–579.

Taxonomic assessment of some pyronemataceous fungi from China

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Abstract — Four new species of the *Pyronemataceae*, *Aleuria medogensis*, *Cheilymenia sinensis*, *Otidea bicolor*, and *Scutellinia setosiopsis*, are described and illustrated. A name change is required for the previously published *Pulvinula guizhouensis*. *Psilopezia nummularialis* and *Smardaea verrucispora* are reported for the first time from China. Comments are made on nine other previously recorded taxa, *Cheilymenia vitellina*, *Humaria semi-immersa*, *Lamprospora haemastigma*, *L. wisconsinensis*, *Otidea abietina*, *Psilopezia deligata*, *Pulvinula laeterubra*, *Trichophaea bullata*, and *T. pseudogregaria*, all of which should be excluded from the Chinese fungus flora.

Key words — *Aleuria*, *Cheilymenia*, *Otidea*, *Scutellinia*, new Chinese records, corrections

Introduction

Early records of the pyronemataceous fungi from China date from Teng's first report on discomycetes (Teng 1934), in which 5 species of the genera *Pyronema* Carus, *Pulvinula* Boud. [as *Psilopezia* Berk.], *Scutellinia* (Cooke) Lambotte [as "*Patella* Weber"], and *Cheilymenia* Boud. [as *Patella*] were recorded. Species of *Lamprospora* De Not., *Melastiza* Boud. and *Sphaerosporella* (Svrček) Svrček & Kubička [as "*Sphaerospora* Sacc."] were later added, and a total of 12 species were known from the country five years later (Teng 1939). Teng's major contribution to taxonomy of the group was summarized in the eminent work "Fungi of China" (Teng 1963, 1996), where 25 taxa belonging to 11 genera were included with diagnostic features, habit, and the known distribution in the country for each species, and in which taxa of *Aleuria* Fuckel, *Geopora* Harkn. [as "*Sepultaria* (Cooke) Lambotte"], *Geopyxis* (Pers.) Sacc., and *Otidea* (Pers.) Bonord. were further recognized. Information about *Pyronemataceae* in China was updated in "Sylloge Fungorum Sinicorum" (Tai 1979), including 40

species of 14 genera with related references, distribution, and habit. Beginning in the 1980's, studies on this fungal group have flourished. Regional floras and detailed treatments of some genera in this family have been published more recently, significantly extending our knowledge of species diversity in China (Wang & Zang 1983; Korf & Zhuang 1984, 1985, 1987; Liu & Cao 1987; Zhuang & Korf 1989; Cao et al. 1990a,b; Zhang 1990; Liu 1991; Zhuang 1994, 2001, 2005, 2006, 2009; Liu & Peng 1996; Zang 1996; Wang 1998; Zhuang & Wang 1998a,b; Yu et al. 2000; Wang & Pei 2001; Zhuang & Yang 2008). Meanwhile, efforts are underway to publish a volume on *Pyronemataceae* as part of the FLORA FUNGORUM SINICORUM. Taxonomic and nomenclatural problems have been encountered and solved, and progress has been achieved. More than 120 taxa belonging 35 genera are recorded thus far. In this study, four species in *Aleuria*, *Cheilymenia*, *Otidea* and *Scutellinia* are described as new to science, attention is called to the requirement for the name change of a previously published taxon, two species are reported for the first time from China, and comments are made on nine previously recorded taxa that should be excluded from the Chinese fungus flora.

Material and methods

Historical specimens of the pyronemataceous fungi from China on deposit in the Mycological Herbarium, Chinese Academy of Sciences (HMAS) and Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS) were re-examined. Recent collections of the family made in 1988–2009 from various areas of China were also identified. Apothecia were rehydrated and sectioned on a freezing microtome (YD-1508A, Yidi Medical Instrument Co., Jinhua, China) at a thickness of 20–25 μm . Measurements were taken from sections mounted in cotton blue-lactophenol solution and from squash mounts in the same medium. For SEM study of the spore surface morphology, a piece of hymenium was cut and attached directly to a stub. The materials were coated with gold-palladium and observed with SEM (FEI Quanta 200). Photographs were taken with a digital camera (Canon G5, Tokyo, Japan) connected to a Zeiss Axioskop 2 plus microscope.

Results and discussion

New species

Aleuria medogensis W.Y. Zhuang, sp. nov.

FIGS. 1A–B, 3A, 5A

MYCOBANK MB 516515

Apotheciis in siccitate 7–20 mm diam.; ascis J–, 230–267 \times 11–13 μm ; ascosporis ellipsoideis vel oblongo-ellipsoideis, 15–18(–19) \times 7.5–9 μm , superficiei hemisphaerice tuberculatis, 0.7–1.8 μm diam.

HOLOTYPE: CHINA. Tibet, Medog, on duff and soil, 20 Aug 1982, X.L. Mao 135, HMAS 53470 (previously filed as *Melastiza chateri*).

ETYMOLOGY: Referring to the place where the fungus was first collected.

Dried apothecia discoid, sessile, 7–20 mm diameter, hymenium surface orange-brown to brown, receptacle surface concolorous, nearly smooth; short cell protrusions arising from the outermost cells of the ectal excipulum, subcylindrical, hyaline, smooth-walled, very short, 15–50 μm long and 5–7.5 μm wide; ectal excipulum of textura angularis, 30–50 μm thick, cells isodiametric or subellipsoid, hyaline, thin-walled, 8–31 \times 7–24 μm or 9–20 μm diameter; medullary excipulum of textura intricata, 280–520 μm thick or thicker, hyphae hyaline, thin-walled, 2–4 μm wide; subhymenium ca 20 μm thick; hymenium 260–280 μm thick; asci operculate, 8-spored, subcylindrical, J– in Melzer's reagent with or without KOH pretreatment, 230–267 \times 11–13 μm ; ascospores ellipsoid to oblong-ellipsoid, hyaline, unicellular, with separate warts on surface, eguttulate, uniseriate, 15–18(–19) \times 7.5–9 μm , spore markings hemispherical, solitary, occasionally 2–3 interconnected, densely distributed, 0.7–1.8 μm wide and 0.5–0.8(–1) μm high; paraphyses filiform, very slightly enlarged at apex, 3–5 μm wide at apex, 2 μm wide below.

NOTES: Among the known species of *Aleuria* (Rifai 1968, Thind & Waraitch 1971, Moravec 1972, 1994; Reid et al. 1981, Häffner 1993), *A. tectipus* (Spooner) W.Y. Zhuang & Korf is the most similar to *Aleuria medogensis* in width of asci and size of ascospores as well as presence of separate warts on the spore surface. *A. tectipus* differs in paler apothecia which are much smaller (up to 6.5 mm diam. when fresh), with shorter asci (160–180 \times 11–13 μm), and uni- to bi-guttulate ascospores with much larger spore ornamentations (3–4 μm diam. and 1.5–3 μm high) (Reid et al. 1981). *Melastiza boudieri* (Höhn.) Le Gal is somewhat similar to *A. medogensis* in ascospore length and the warted spore surface, but it differs significantly in the brownish and longer hairs (70–250 \times 9–16 μm), wider ascospores [(15–)16.5–19.5(–21) \times 9.2–12.5(–15) μm], spore markings connected by fine crests and larger hemispherical markings (1.5–3(–4.5) μm diam.), and much smaller apothecia only 3–7 mm diam. when fresh (Moravec 1994).

***Cheilymenia sinensis* W.Y. Zhuang, sp. nov.**

FIGS. 1C–E, 3B, 5B, 6A

MYCOBANK MB 516516

Apotheciis discoideis, 1.5–4 mm diam., hymeniis luteis vel pallide persicino-flavis, receptaculis hirsutis; ascis J–, 167–216 \times 10–12.5 μm ; ascosporis ellipsoideis, eguttulatis, 14–16.5 \times 8–10.5 μm .

HOLOTYPE: CHINA. Sichuan, Daocheng, 3900 m, on yak dung, 4 Jul 1998, Z. Wang 34, HMAS 75942 (previously filed as *Cheilymenia coprinaria*).

ETYMOLOGY: Referring to the country where the fungus was first collected.

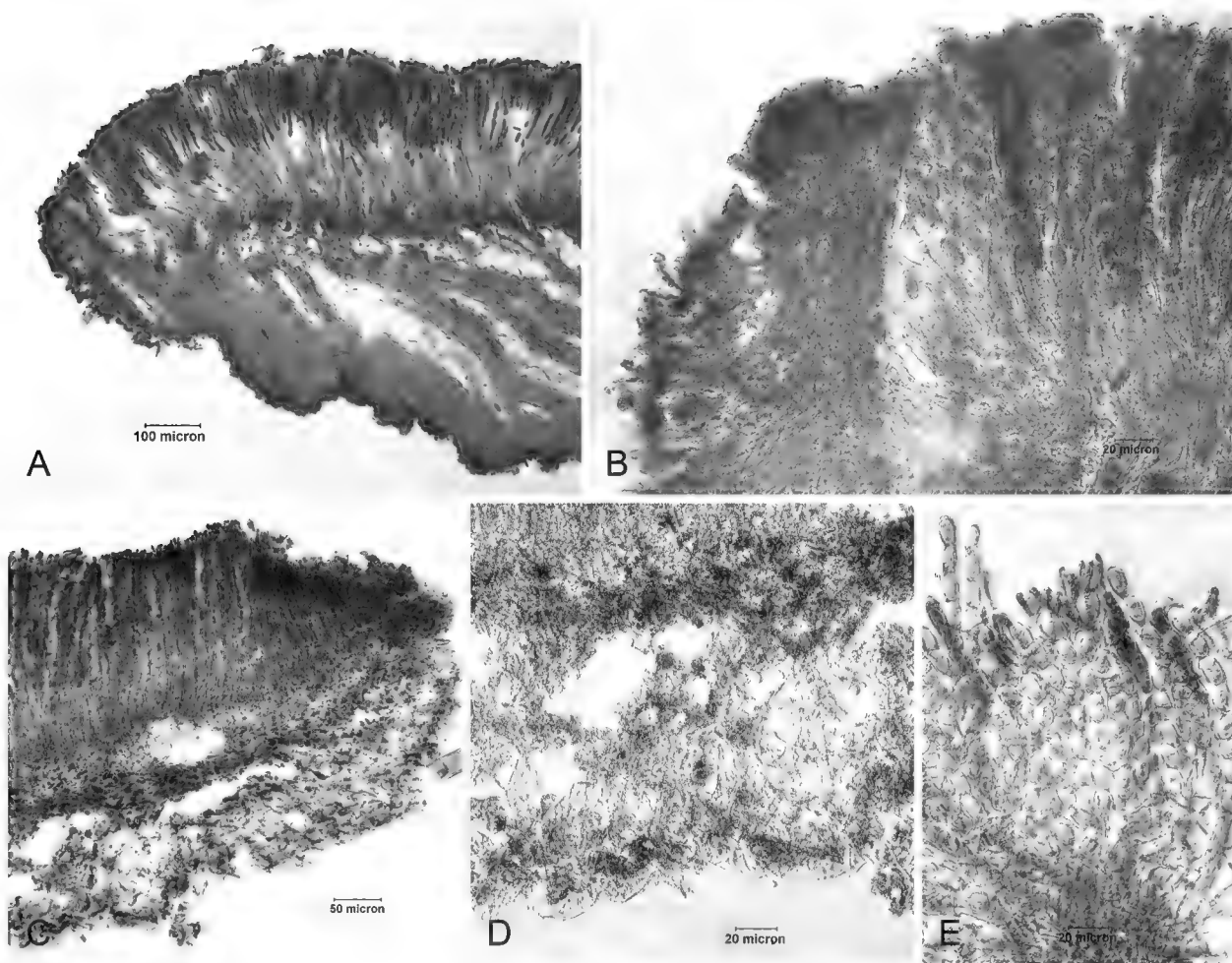


FIG. 1. Morphology of *Aleuria medogensis* and *Cheilymenia sinensis*. A–B. *Aleuria medogensis* (HMAS 53470). A. Anatomy of apothecium. B. Structure of apothecium at margin. C–E. *Cheilymenia sinensis* (HMAS 188412). C. Anatomy of apothecium. D. Structure of ectal excipulum. E. Portion of hymenium.

Apothecia discoid, sessile, 1.5–4 mm in diameter, hymenium surface orange-yellow to light pinkish yellow, receptacle lighter than hymenium, surface covered with setae arising from inner cells of excipulum, brown to light brown, with 1–2 rootlets at base, mostly with 4–9 septa, $180\text{--}500 \times 18\text{--}33$, walls $2\text{--}5\text{ }\mu\text{m}$ thick; ectal excipulum of textura angularis, $50\text{--}165\text{ }\mu\text{m}$ thick, cells nearly isodiametric, walls of outermost cells somewhat brownish and of inner ones subhyaline, $23\text{--}51 \times 12\text{--}30\text{ }\mu\text{m}$ or $13\text{--}55\text{ }\mu\text{m}$ diameter if isodiametric; medullary excipulum of textura intricata, $38\text{--}115\text{ }\mu\text{m}$ thick, hyphae hyaline, thin-walled, $2.5\text{--}9\text{ }\mu\text{m}$ wide; subhymenium not clearly distinguishable, $0\text{--}20\text{ }\mu\text{m}$ thick; hymenium $185\text{--}203\text{ }\mu\text{m}$ thick; asci operculate, 8-spored, subcylindrical, J– in Melzer's reagent with or without KOH pretreatment, $167\text{--}216 \times 10\text{--}12.5\text{ }\mu\text{m}$; ascospores rectangular-ellipsoid, broadly ellipsoid to ellipsoid, with ends blunt, eguttulate, with contents refractive, sometimes with a de Bary bubble, surface very minutely granulate, $14\text{--}16.5 \times 8\text{--}10.5\text{ }\mu\text{m}$; paraphyses filiform, slightly wider at apex, $3.5\text{--}4.5\text{ }\mu\text{m}$ wide at apex and $2\text{ }\mu\text{m}$ wide below.

PARATYPES: CHINA. Qinghai, Ledu, 2800 m, on cow dung, 11 Aug 2004, W. Y. Zhuang & C. Y. Liu 5259, HMAS 188412; Qinghai, Datong, alt. 3000 m, on cow dung, 17 Aug 2004, W. Y. Zhuang 5388-1, HMAS 188413.

NOTES: Among the known species of *Cheilymenia* (Moravec 2005), *C. coprinaria* (Cooke) Boud. resembles the new species in length of ascospores, length of asci, and color of hymenium, but it produces somewhat larger apothecia [(2–)3–7(–10) mm diam.], much longer hairs (150–800(–1050) \times 15–35(–45) μ m], and a base that is bifurcate or (usually) multifurcate rather than having 1–2 rootlets. It also has wider asci (135–23 \times 12–15 μ m), narrower ascospores [(12.5–)13.5–17(–19) \times (6.8–)7.5–9.2(–10.8) μ m], densely distributed spore ornamentations, and obviously enlarged paraphysis apices (4.5–7.5(–9) μ m wide).

Cheilymenia dennisii J. Moravec is somewhat similar to *C. sinensis* in size of apothecia, shape of ascospores, and size of setae, but differs in having much wider asci (170–240 \times (13.5–)15–18 μ m), larger spores [(14.5–)15.5–19.5(–21) \times (8–)9.5–12.2(–13.5) μ m] with higher and denser spore ornamentations, as well as wider paraphyses of a different shape and 6–10(–12) μ m wide at apex (Moravec 2005). The ascospore surface morphology (SEM) of *Cheilymenia sinensis* is also similar to that of *C. magnipila* J. Moravec, but the two species differ significantly in many other aspects (Moravec 2005).

Otidea bicolor W.Y. Zhuang & Zhu L. Yang, sp. nov.

FIGS. 2A–C, 4, 5C

MYCOBANK MB 516517

Apotheciis cupulatis, fissilibus, brevistipitatis, hymeniis leviter aurantiacis vel luteis, receptaculis leviter violaceis-brunneis; ascis J–, 140–182 \times 9–10.5 μ m; ascosporis ellipsoideis, biguttulatis, 10–12 \times 5.5–6 μ m.

HOLOTYPE: CHINA. Yunnan, Kunming, Heilongtan Park, on the ground among fallen conifer needles in mixed conifer and broadleaf tree forest, 16 Aug 2008, Z. L. Yang 5156, HKAS 54453 **holotype**; HMAS 188415 (isotype).

ETYMOLOGY: Referring to significant color difference between hymenium and receptacle surface.

Apothecia deep-cupulate with a split down to the base, short-stipitate, truncate, 10–22 mm wide when dry, hymenium surface light dirty orange to beige when fresh, receptacle surface light vinaceous brown or brown with a purplish tint when fresh, nearly smooth to minutely granulate; ectal excipulum of texture angularis mixed with textura globulosa, with small pustules on the surface and a few very short hyphal protrusions, 35–60 μ m thick (excluding pustules), cells angular to subglobose, subhyaline, thin-walled, 8–23 μ m diameter or 15–23 \times 10–18 μ m, pustules 20–60 μ m high, cells in pustules commonly isodiametric, 8–18 μ m diameter; medullary excipulum of textura intricata, 300–1400 μ m thick, hyphae hyaline, thin-walled, 3.5–12.5 μ m wide; subhymenium not clearly distinguishable; hymenium 150–160 μ m thick; asci subcylindrical, operculate,

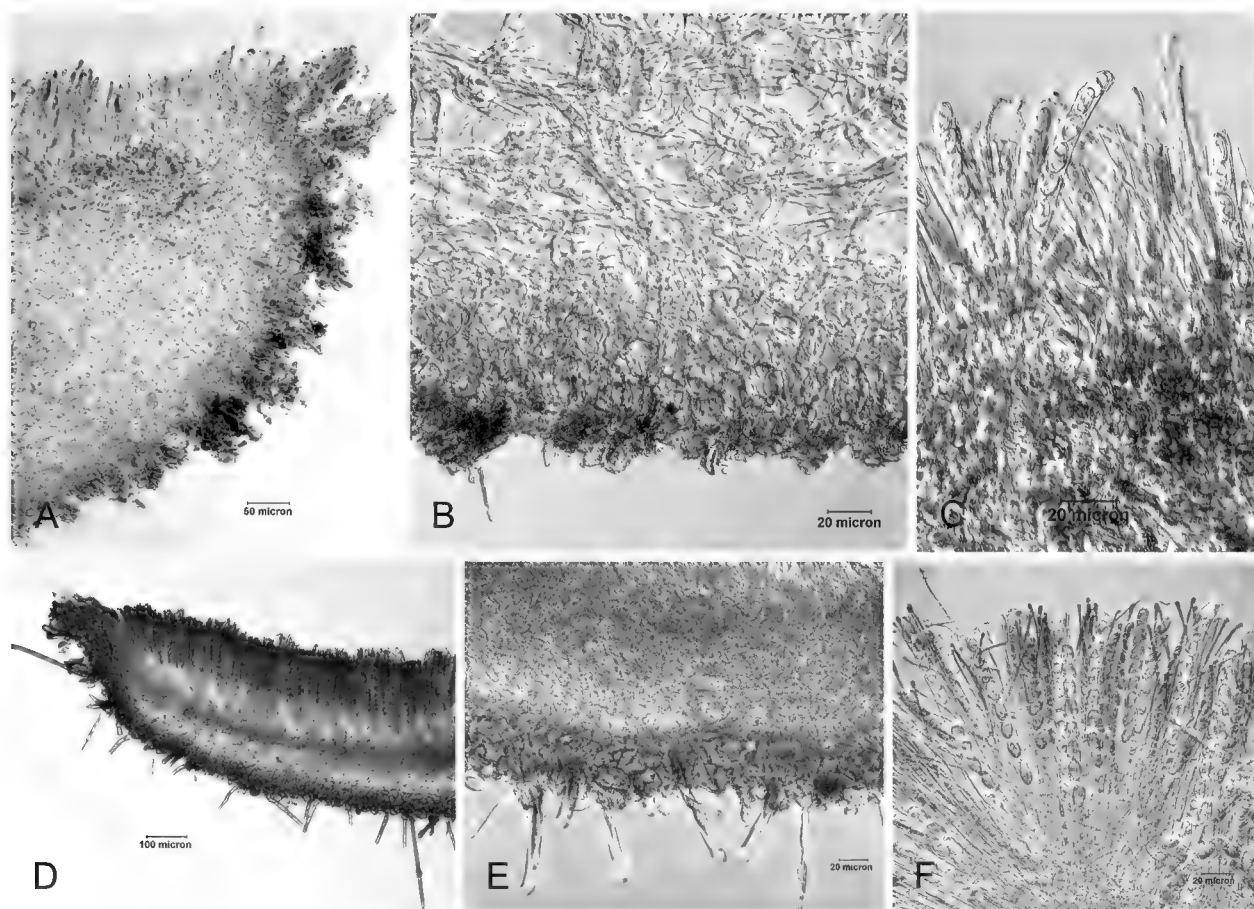


FIG. 2. Morphology of *Otidea bicolor* and *Scutellinia setosiopsis*. A–C. *Otidea bicolor* (HKAS 54453). A. Anatomy of apothecium near margin. B. Structure of excipulum. C. Asci and paraphysis apices. D–F. *Scutellinia setosiopsis* (HMAS 76074). D. Anatomy of apothecium. E. Structure of excipulum. F. Asci and paraphyses.

8-spored, J– in Melzer's reagent with or without KOH pretreatment, $140\text{--}182 \times 9\text{--}10.5\ \mu\text{m}$; ascospores ellipsoid, smooth-walled, hyaline, unicellular, biguttulate, uniseriate, $10\text{--}12 \times 5.5\text{--}6\ \mu\text{m}$; paraphyses filiform, curved or circinate at apex, septate, $2.5\text{--}3.5\ \mu\text{m}$ wide at apex, $1.8\text{--}2.5\ \mu\text{m}$ below.

NOTES: This species is characterized by the combination of deep-cupulate apothecia with a split down to the base, significant color difference between the light dirty orange to beige hymenium surface and light vinaceous brown receptacle surface, which looks minutely granulate, and smooth-walled, $10\text{--}12 \times 5.5\text{--}6\ \mu\text{m}$ ascospores.

Among the known species of the genus, *Otidea sinensis* J.Z. Cao & L. Fan is possibly the closest and most similar species to *O. bicolor*. Both species show significant color contrast between the surface of the hymenium and of the receptacle and the size of asci and of ascospores are similar; they differ in apothecial color and shape and excipular structure. The former has broad-spathulate apothecia with a maize yellow disc and amber brown receptacle

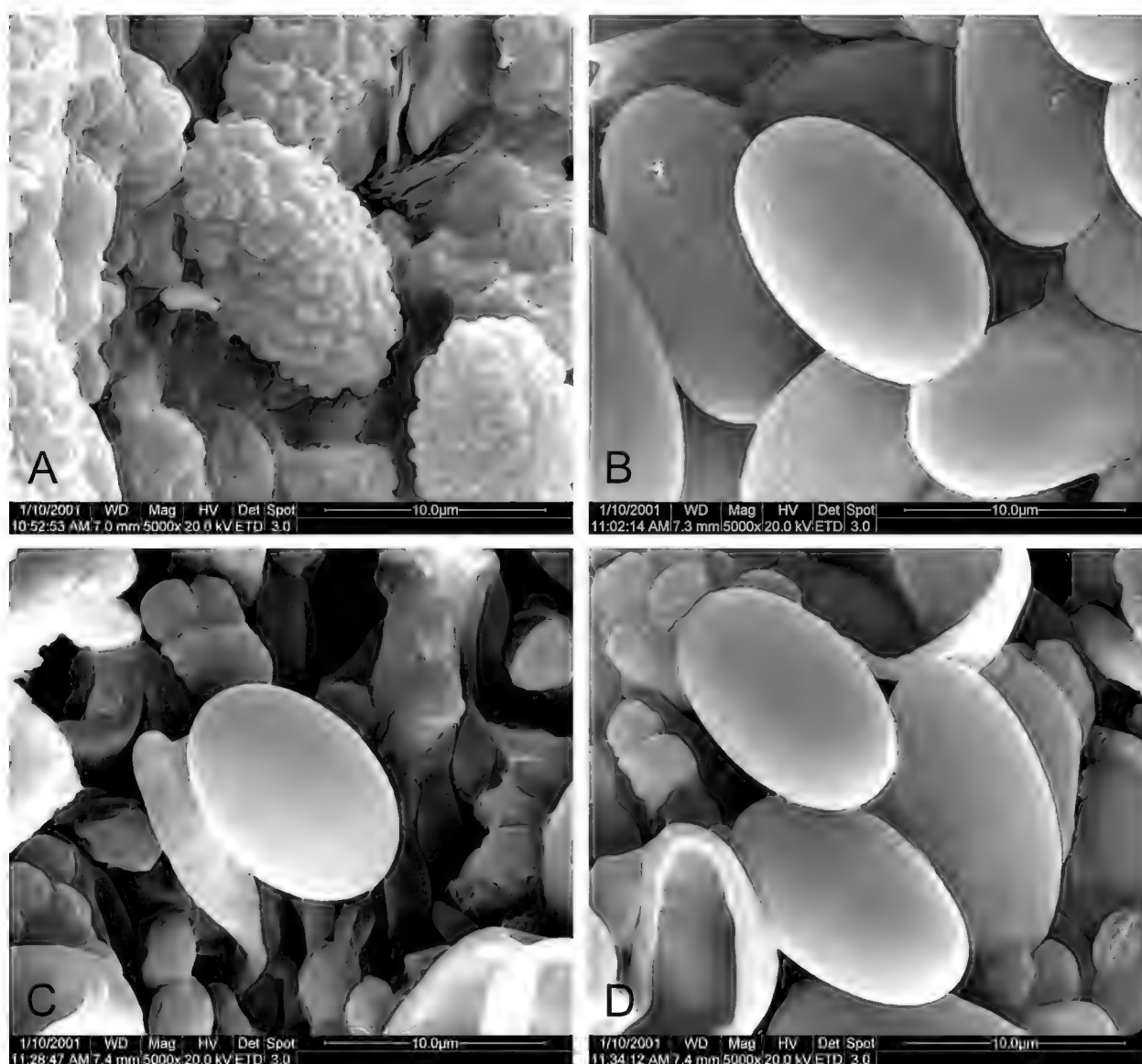


FIG. 3. SEM of ascospore surface morphology. A. *Aleuria medogensis*, from HMAS 53470. B. *Cheilymenia sinensis*, from HMAS 188412. C–D. *Scutellinia setosiopsis*, from HMAS 76074.

surface in fresh condition, cells of pustules commonly elongate and arranged in chains like those of *Helvella* species with a villose receptacle surface, and wider paraphyses (Cao et al. 1990a).

When apothecial shape and color contrast between disc and receptacle surface are considered, *Otidea grandis* (Pers.) Rehm is also similar, but differs obviously in the yellow hymenium and grayish brown to yellowish gray receptacle, ascospores that are elongate-ellipsoid to fusoid-ellipsoid, $14\text{--}17 \times 6\text{--}7 \mu\text{m}$, and have irregular crests on the spore surface (Boudier 1905–1911, Kanouse 1949, Liu & Zhuang 2006). *Otidea yunnanensis* (B. Liu & J.Z. Cao) W.Y. Zhuang & C.Y. Liu has a similar disc color, but possesses a spatulate apothecium with a long, tough, warm brown stalk and a brown to grayish brown receptacle surface lacking any purplish tint and larger ascospores $16.5\text{--}20 \times 7.6\text{--}10 \mu\text{m}$ with spine-like ornamentations (Liu & Cao 1987, Liu & Zhuang 2006).



FIG. 4. Apothecia of *Otidea bicolor* on natural substrate, from HKAS 54453.

***Scutellinia setosiopsis* W.Y. Zhuang, sp. nov.**

FIGS. 2D–F, 3C–D, 5D, 6B

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Apotheciis discoideis, sessilibus, 3–5 mm in diam., hymeniis vitellinis, receptaculis hirsutis; pili setosis, brunneis, 55–820 × 11–25 µm; ascis J–, 218–274 × 10–12.7 µm; ascosporis ellipsoideis, 1(–2)-guttulatis, (13–)14–17.5 × 7.5–9.5(–10) µm.

HOLOTYPE: CHINA. Beijing, Dongling Mountains, on rotten wood, 4 Sept 1999, Z. Wang 320, HMAS 76074 (previously filed as *Cheilymenia* sp.).

ETYMOLOGY: Referring to the similar spore surface morphology to *Scutellinia setosa*.

Apothecia discoid, sessile, 3–5 mm in diameter, margin thin and distinct, hymenium surface egg-yellow when fresh and dirty orange to brown when dry, receptacle surface covered by brown setae arising from inner cells of excipulum or from brown and thick-walled outer cells, with 0–1–2(–3) rootlets, brown, 2- to multi-septate, mostly 55–820 µm long, 11–25 µm wide, walls 2–4.5 µm thick, with very short and light brown hairs with a blunt apex that are scattered at the apothecial base; ectal excipulum of *textura angularis*, 60–75 µm thick, cells angular to subglobose, subhyaline to light brown, 10–25 µm diameter or 18–38 × 9–33 µm, walls 1–1.3 µm thick; medullary excipulum of *textura intricata*, 50–100 µm thick, hyphae subhyaline, thin-walled, 2.5–7.5 µm wide; subhymenium not distinguishable; hymenium 240–255 µm thick; asci

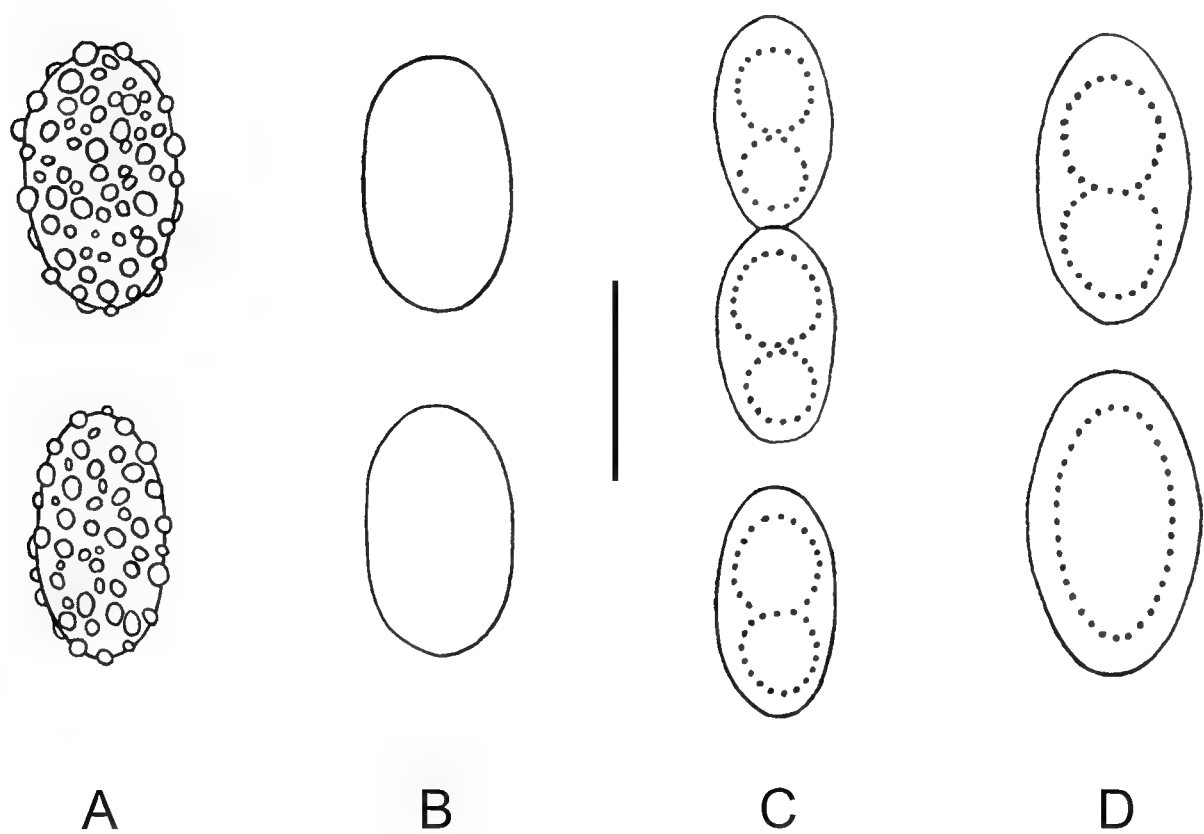


FIG. 5. Ascospore morphology.

A. *Aleuria medogensis*, from HMAS 53470. B. *Cheilymenia sinensis*, from HMAS 188412.

C. *Otidea bicolor*, from HKAS 54453. D. *Scutellinia setosiopsis*, from HMAS 76074.

Scale bar = 10 μm .

subcylindrical, operculate, 8-spored, J– in Melzer’s reagent with or without KOH pretreatment, $218\text{--}274 \times 10\text{--}12.7 \mu\text{m}$; ascospores ellipsoid, surface nearly smooth, hyaline, unicellular, with 1–2 guttules, uniseriate, $(13\text{--})14\text{--}17.5 \times 7.5\text{--}9.5(\text{--}10) \mu\text{m}$; paraphyses filiform, very slightly enlarged at apex, $2.5\text{--}3.8 \mu\text{m}$ wide at apex, $2 \mu\text{m}$ wide below.

NOTES: Among taxa of *Scutellinia* possessing nearly smooth-walled ascospores under the light microscope, *S. setosa* (Nees) Kuntze and *S. setosissima* Le Gal (Schumacher 1990) are similar to *S. setosiopsis*. *Scutellinia setosa* differs from the new species in smaller apothecia ($1\text{--}2.5 \text{ mm}$ diam.) with reddish to red brown hymenium, longer and wider hairs ($450\text{--}880 \times 15\text{--}30 \mu\text{m}$), larger ectal excipular cells ($20\text{--}60 \mu\text{m}$ diam.), and larger ascospores ($17.8\text{--}20.6 \times 10.2\text{--}12.4 \mu\text{m}$). *Scutellinia setosissima* is characterized by a hymenium surface that is ochraceous white when dry, longer and wider setae ($450\text{--}1250 \times 25\text{--}35 \mu\text{m}$), wider asci ($195\text{--}240 \times 12.8\text{--}16.5 \mu\text{m}$), much larger ascospores ($17.8\text{--}23.5 \times 9.8\text{--}13.2 \mu\text{m}$), and enlarged paraphysis apices $6\text{--}10 \mu\text{m}$ wide. The new species is characterized by the combination of yellow hymenium, narrow hairs $11\text{--}25 \mu\text{m}$ wide, and nearly smooth-walled ascospores $(13\text{--})14\text{--}17.5 \times 7.5\text{--}9.5(\text{--}10) \mu\text{m}$, which make it distinctive in the genus.

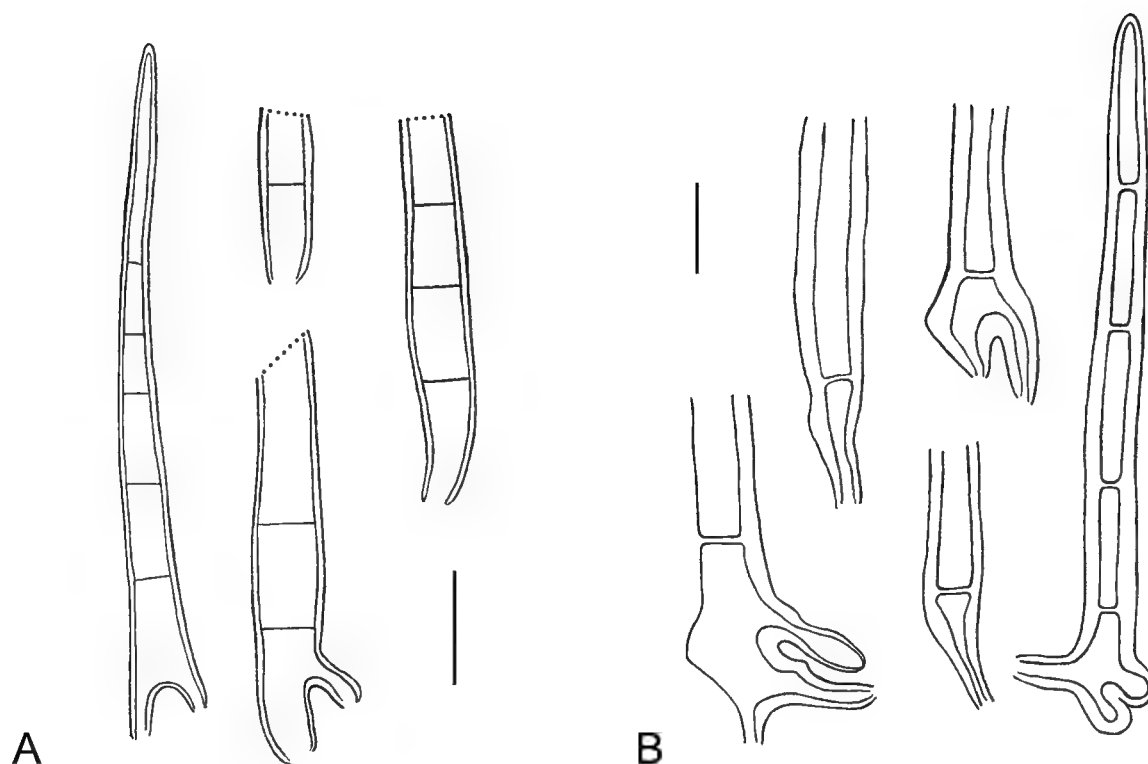


FIG. 6. Hair morphology.
A. *Cheilymenia sinensis*, from HMAS 188412. B. *Scutellinia setosiopsis*, from HMAS 76074.
Scale bars: A = 50 μ m, B = 20 μ m.

Name change for a previously published taxon

Pulvinula guizhouensis M.H. Liu, Acta Mycol. Sinica 10: 187, 1991.

= *Pulvinula globifera* (Berk. & M.A. Curtis) Le Gal,
Prodr. Flore Mycol. Madagascar 4: 94, 1953.

SPECIMEN EXAMINED: CHINA. Guizhou, Suiyang, alt. 1450 m, on sandy soil in broadleaf forest, 11 Aug 1987, M. H. Liu 1017 (holotype of *Pulvinula guizhouensis*); HMAS 97546 (isotype).

OTHER SPECIMENS EXAMINED: CHINA. Yunnan, Jizushan, on the ground, 12 Sept 1938, H. S. Yao, HMAS 17131 (previously filed as *Lamprospora wisconsinensis*); Yunnan, Kunming, on the ground, 13 Oct 1938, C. C. Cheo, HMAS 17132 (previously filed as *Lamprospora wisconsinensis*); Beijing, Qinghuayuan, on the ground, L. Shi, May 1935, HMAS 17133 (previously filed as *Lamprospora* sp.).

NOTES: Re-examination of the holotype of *Pulvinula guizhouensis* (LMH 1017) and consultation of the original description of the fungus (Liu 1991) indicate that it is identical to *P. globifera* as described by Rifai (1968). The latter name has the priority and is the correct name for the fungus.

New records for China

Psilopezia nummularialis Pfister & Cand., Mycotaxon 13: 367, 1981.

SPECIMENS EXAMINED: CHINA. China, Hubei, Wufeng County, Houhe Nature Reserve, alt. 800 m, on rotten bark, 12 Sept 2004, W. Y. Zhuang & C. Y. Liu 5528, 5530, 5531, HMAS 173269, 173270, 173271.

Smardaea verrucispora (Donadini & Monier) Benkert, Zeit. Mykol. 71: 148, 2005.

SPECIMEN EXAMINED: CHINA. China, Yunnan, Kunming, Xishan, on the ground, 14 Jul 1938, C. C. Cheo, HMAS 17134 (previously filed as *Lamprospora* sp.).

Previously recorded species that should be excluded from the Chinese fungus flora

Cheilymenia vitellina (Pers.) Dennis, British Cup-fungi and Their Allies p. 27, 1960.

CHINESE RECORD: Zhuang, Fungi of Northwestern China, p. 104, 2005.

NOTES: The Chinese record of *Cheilymenia vitellina* was based on a single collection (HMAS 83254) from northwestern China labelled as *C. vitellina* on deposit in the Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (Zhuang 2005). Re-examination of the material reveals that it possesses all the features of the genus *Tricharina* Eckblad (Yang & Korf 1985), such as apothecia cupulate, semi-immersed in soil, broadly attached to substrate, hairs arising from surface cells of ectal excipulum and not rooting at base, and 8 ascospores almost completely filling the ascus. The previous Chinese record of *C. vitellina* is based on a misidentification.

Humaria semi-immersa (P. Karst.) Sacc., Syll. Fung. 8: 143, 1889.

= *Sepultariella semi-immersa* (P. Karst.) Kutorga, Lietuvos Grybai (Vilnius) 3(5): 188, 2000, nom. provis.

CHINESE RECORD: Tai, Sylloge Fungorum Sinicorum, p. 159, 1979.

NOTES: The true *Humaria semi-immersa* is no longer considered to be a member of *Humaria* Fuckel in the current sense (Korf 1973) and has been transferred provisionally to a new genus *Sepultariella* Kutorga nom. provis. (Kutorga 2000). Dr. E. Kutorga kindly provided the following information based on his examination of the type material of this fungus: this species is affiliated with a *Peziza* (*Leucoscypha*) species or related fungi and its ascospores are (1–)2-guttulate (Kutorga pers commun).

The Chinese record of *Humaria semi-immersa* was based on the collections so labelled and deposited in HMAS (Tai 1979). Re-examinations of all specimens filed under this name (HMAS 12163, 17269, 33723) show that they belong to the genera *Geopora* and *Cheilymenia*. The previous record of *H. semi-immersa* is based on misidentifications.

Lamprospora haemastigma (Hedw.) Seaver, Mycologia 6: 17, 1914.

CHINESE RECORD: Teng, Fungi of China, p. 287, 1963.

NOTES: The taxonomic viewpoint on *Pulvinula* by Pfister (1976) is followed here, and *Pulvinula haemastigma* is treated as a nomen confusum.

Teng (1963) and Tai (1979) obviously accepted the species concept of *Lamprospora haemastigma* by Seaver (1928), who treated *Lamprospora* in a very broad sense. Judging from the description of “*L. haematostigma*” from Gansu Province by Teng (1963, 1996), the fungus possesses all the features of *Pulvinula* Boud. Re-examination of the only material on deposit in HMAS filed under “*Lamprospora haematostigma*” (HMAS 08974 collected and identified by S.C. Teng) indicates that the correct name for the fungus is *Pulvinula carbonaria* (Fuckel) Boud., which is recorded here for the first time from the mainland of China.

Lamprospora wisconsinensis Seaver, North American Cup-fungi (Operculates) p. 69, 1928.

CHINESE RECORD: Tai, Sylloge Fungorum Sinicorum p. 181, 1979.

NOTES: *Lamprospora wisconsinensis* was treated as a synonym of *Pulvinula laeterubra* by Pfister (1976). Tai's report of *L. wisconsinensis* was based on two specimens deposited in HMAS (HMAS 17131, 17132) from Yunnan Province. Re-examinations of these collections indicate that the correct name for the fungus is *Pulvinula globifera* (Rifai 1968).

Peziza abietina Pers., Neues Mag. Bot. 1: 113, 1794, sensu Seaver, North American Cup-fungi (Operculates) p. 228, 1928.

= *Otidea abietina* (Pers.) Fuckel, Jahrb. Nassauischen Vereins Naturk. 23–24: 330, 1870, sensu Kanouse, Mycologia 41: 675, 1949.

CHINESE RECORDS: Teng, Fungi of China p. 291, 1963. Tai, Sylloge Fungorum Sinicorum p. 262, 1979. Wang & Zang, Fungi of Xizang p. 25, 1983.

NOTES: For a long time, this name was commonly applied to a species of *Otidea* (Kanouse 1949). As indicated by Nannfeldt (1966) based on his study of authentic material of *Peziza abietina*, it is not a member of *Otidea* but a rough-spored member of *Peziza* Dill. ex Fr.

Teng (1963, 1996) reported “*Peziza abietina*” from Gansu Province as fruitbodies regular to irregular-cupulate, light brown, with a coarse and short stalk, ascospores ellipsoid containing a single large guttule, paraphyses enlarged at the apex. These characters do not fit the genus *Otidea*. Re-examination of the only specimen filed under *P. abietina* from Gansu and identified by S.C. Teng (HMAS 30799) indicates that though the morphology of the fungus is identical with Teng's description of “*Peziza abietina*” it is not a *Peziza* judging from the J-asci in Melzer's reagent. Its gross morphology is like those members of *Helvella* with cupulate fruitbodies, and its ascospores also resemble those of *Helvella* species, though the excipular structure seems to be different from *Helvella*.

The Chinese record of “*Peziza abietina*” by Tai (1979) is based on collections from Heilongjiang, Shanxi and Inner Mongolia on deposit in HMAS (HMAS

33642, 33848, 39243) and Teng's previous report (Teng 1963). Re-examinations of the above three specimens show that they are not *Otidea* species; rather one is *Urnula craterium* (Schwein.) Fr. and two are true *Peziza* species with warts and crests on the ascospores. The two *Peziza* specimens were examined and annotated in 1995 by D.H. Pfister as "*Peziza* sp., not *P. abietina*" for 33848 and "*Peziza* sp." for 39243. According to the ascospore size of both *Peziza* collections from China, they are neither *Otidea abietina* as circumscribed by Fuckel (1870), nor *Otidea abietina* sensu Kanouse (1949), nor even *Peziza abietina* sensu Saccardo (1889). "*Peziza abietina*" was also reported from Bomi, Tibet (Xizang) based a single collection deposited in HKAS (HKAS 5858) (Wang & Zang 1983). Re-examination of the collection indicates that its gross morphology and ascospore size do not fit the concept of *O. abietina* sensu Kanouse, but rather that of *O. alutacea* (Pers.) Masee var. *alutacea* (Kanouse 1949).

Psilopezia deligata (Peck) Seaver, North American Cup-fungi (Operculates) p. 107, 1928.

CHINESE RECORD: Wang & Pei, Mycotaxon 79: 311, 2001.

NOTES: *Psilopezia deligata* was reported from Dongling Mountains, Beijing (Wang & Pei 2001) based on a single collection (HMAS 74678). Re-examination of the fungus reveals that it represents *P. dabaensis* W.Y. Zhuang (Zhuang 1997). *Psilopezia deligata* differs from the Chinese material in smaller fruitbodies, larger ascospores, and narrower asci (Pfister 1973).

Pulvinula laeterubra (Rehm) Pfister, Occ. Pap. Farlow Herb. Crypt. Bot. 9: 11 (1976).

CHINESE RECORD: Wang & Pei, Mycotaxon 79: 311, 2001.

NOTES: Wang & Pei (2001) reported this species from China based on collections from Dongling Mountains, Beijing on deposit in HMAS. Both specimens under this name from Dongling Mountains identified by Z. Wang (HMAS 75887, 76048) were re-examined. My observations indicate that they are not *P. laeterubra* but *P. miltina* (Berk.) Rifai as evidenced by presence of the short hair-like hyphae about 2.5 µm diameter covering the receptacle surface (Rifai 1968).

Trichophaea bullata Kanouse, Mycologia 50: 131, 1958.

CHINESE RECORD: Wang & Pei, Mycotaxon 79: 312, 2001.

NOTES: *Trichophaea bullata* was recorded from Dongling Mountains, Beijing (Wang & Pei 2001) based on a single collection (HMAS 74650). Re-examination of the fungus indicates that its hair base is never swollen to 30–35 µm in diameter as is characteristic of *T. bullata* (Kanouse 1958) and it fits well within the scope of *T. woolhopeia* (Cooke & W. Phillips) Arnould.

Trichophaea pseudogregaria (Rick) Boud., Histoire et Classification des Discomycètes d'Europe p. 60, 1907.

CHINESE RECORD: Zhuang, Mycotaxon 79: 378, 2001.

NOTES: *Trichophaea pseudogregaria* was recorded from China based on a single collection (HMAS 72821) on deposit in HMAS and so labeled (Zhuang 2001). Re-examination of the specimen shows that *T. gregaria* (Rehm) Boud. is the correct name for the fungus.

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Literature cited

- Boudier E. 1905–1910. Icones Mycologicae. 4 volumes. Paris. p 1–221.
- Cao JZ, Fan L, Liu B. 1990a. Some species of *Otidea* from China. Mycologia 82: 734–741.
- Cao JZ, Fan L, Liu B. 1990b. Notes on the genus *Smardaea* in China. Acta Mycol. Sinica 9: 282–285.
- Dennis RWG. 1978. British Ascomycetes. Ed. 2. Vaduz: Cramer. p 1–280.
- Harmaja H. 1976. New species and combinations in the genera *Gyromitra*, *Helvella* and *Otidea*. Karstenia 15: 29–32.
- Häffner J. 1993. Die Gattung *Aleuria*. Rheinl-Pfäl. PilzJourn. 3(1): 6–59.
- Kanouse BB. 1949. Studies in the genus *Otidea*. Mycologia 41: 660–677.
- Kanouse BB. 1958. Some species of the genus *Trichophaea*. Mycologia 50: 121–140.
- Korf RP. 1973. *Discomycetes* and *Tuberales*. In: Ainsworth GC, Sparrow FK, Sussman AS [eds.] The fungi: an Advanced Treatise. Vol. 4A. New York and London: Academic Press. p 249–319.
- Korf RP, Zhuang WY. 1984. The ellipsoid-spored species of *Pulvinula* (*Pezizales*). Mycotaxon 20: 607–616.
- Korf RP, Zhuang WY. 1985. Some new species and new records of discomycetes in China. Mycotaxon 22: 483–514.
- Korf RP, Zhuang WY. 1987. *Geneosperma* Rifai (*Pezizales*, *Scutellinioideae*) and its folliculate ascospores. Acta Mycol. Sinica Suppl. 1: 90–96.
- Kutorga E. 2000. *Pezizales*. Mycota Lithuaniae III 5. Vilnius: Institutum Botanicae Lithuaniae. p 1–275.
- Liu B, Cao JZ. 1987. *Otideopsis yunnanensis* gen. et sp. nov. of *Pezizales* from China and its position in *Pezizales* system. Acta Shanxi Univ. 1987(4): 70–73.
- Liu CY, Zhuang WY. 2006. Relationship among some members of the genus *Otidea* (*Pezizales*, *Pyronemataceae*). Fungal Divers. 23: 181–192.

- Liu MH. 1991. Two new species of *Pulvinula* from China. *Acta Mycol. Sinica* 10: 185–189. (in Chinese)
- Liu MH, Peng HW. 1996. *Scutellinia sinensis*, a new spherical-spored species of *Scutellinia*. *Acta Mycol. Sinica* 15: 98–100.
- Moravec J. 1972. Operculate discomycetes of the genera *Aleuria* Fuck. and *Melastiza* Boud. from the district of Mlada Boleslav (Bohemia). *Česká Mykol.* 26: 74–81.
- Moravec J. 1994. *Melastiza* (Boud.) comb. et stat. nov. – a subgenus of the genus *Aleuria* Fuck. emend. nov (*Discomycetes*, *Pezizales*). *Czech Mycol.* 47: 237–259.
- Moravec J. 2005. A world monograph of the genus *Cheilymenia* (*Discomycetes*, *Pezizales*, *Pyronemataceae*). *Libri Bot.* 21: 1–256.
- Nannfeldt JA. 1966. On *Otidea caligata*, *O. indivisa* and *O. platyspora* (*Discomycetes* Operculatae). *Ann. Bot. Fenn.* 3: 309–318.
- Pfister DH. 1973. The psilopezoid fungi. III. The genus *Psilopezia* (*Pezizales*). *Amer. J. Bot.* 60: 355–365.
- Pfister DH. 1976. A synopsis of the genus *Pulvinula*. *Occas. Pap. Farlow Herb. Crypt. Bot.* 9: 1–19.
- Reid A, Pegler DN, Spooner BM. 1981. Annotated list of the fungi of Galapagos Islands. *Kew Bull.* 35: 847–892.
- Rifai MA. 1968. The Australasian *Pezizales* in the herbarium of the Royal Botanic Gardens Kew. *Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., Tweede Sect.* 57(3): 1–295.
- Saccardo PA. 1889. *Sylloge Fungorum*. Vol. 8. Padova. p 1–1143.
- Saccardo PA. 1899. *Sylloge Fungorum*. Vol. 14. Padova. p 1–1316.
- Schumacher T. 1990. The genus *Scutellinia* (*Pyronemataceae*). *Opera Bot.* 101: 1–107.
- Seaver FJ. 1928. *The North American Cup-fungi (Operculates)*. New York: Seaver. p 1–284.
- Tai FL. 1979. *Sylloge Fungorum Sinicorum*. Beijing: Science Press. p 1–1527. (in Chinese)
- Teng SC. 1934. Notes on discomycetes from China. *Sinensia* 5: 431–465.
- Teng SC. 1939. A Contribution to our Knowledge of the Higher Fungi of China. Yangshuo: National Institute of Zoology and Botany, Academia Sinica. p 1–614.
- Teng SC. 1963. *Fungi of China*. Beijing: Science Press. p 1–808. (in Chinese)
- Teng SC [Korf RP, ed]. 1996. *Fungi of China*. Ithaca: Mycotaxon Ltd. p 1–586.
- Thind KS, Waritch KS. 1971. The *Pezizales* of India – XIV. *Proc. Indian Acad. Sci., Sect. B* 74(6): 269–276.
- Wang Yei Z. 1998. The genera *Scutellinia* and *Geneosperma* (*Discomycetes*, *Pezizales*) in Taiwan. *Bull. Natl. Mus. Nat. Sci.* 11: 119–128.
- Wang Yun Z, Zang M, ed. 1983. *Fungi of Xizang*. Beijing: Science Press. p 1–226. (in Chinese)
- Wang Z, Pei KQ. 2001. Notes on discomycetes in Dongling Mountains (Beijing). *Mycotaxon* 79: 307–314.
- Yang CS, Korf RP. 1985. A monograph of the genus *Tricharina* and of a new segregate genus, *Wilcoxina* (*Pezizales*). *Mycotaxon* 24: 467–531.
- Zang M, ed. 1996. *Fungi of the Hengduan Mountains*. Beijing: Science Press. p 1–598. (in Chinese)
- Zhang BC. 1990. Taxonomic status of *Genabea*, with two new species of *Genea* (*Pezizales*). *Mycol. Res.* 95: 986–994.
- Zhang BC, Yu YN. 1992. Revision of Chinese species of *Geopora* (*Pezizales*). *Acta Mycol. Sinica* 11: 8–14. (in Chinese)
- Zhuang WY. 1994 [“1993”]. Current understanding of the genus *Scutellinia* (*Pezizales*, *Otideaaceae*) in China. *Mycosystema* 6: 13–24.
- Zhuang WY. 1997. Fungal flora of the Daba Mountains: Discomycetes. *Mycotaxon* 61: 3–12.

- Zhuang WY, ed. 2001a. Higher Fungi of Tropical China. Ithaca: Mycotaxon Ltd. p 1–485.
- Zhuang WY. 2001b. A list of discomycetes in China. Supplement I. Mycotaxon 79: 375–381.
- Zhuang WY, ed. 2005. Fungi of Northwestern China. Ithaca: Mycotaxon Ltd. p 1–430.
- Zhuang WY. 2006 [“2005”]. Notes on *Otidea* from Xinjiang, China. Mycotaxon 94: 365–370.
- Zhuang WY. 2009. The genus *Sowerbyella* (*Pezizales*) in China. Mycotaxon 109: 233–237.
- Zhuang WY, Korf RP. 1989. Some new species and new records of discomycetes in China. III. Mycotaxon 35: 297–312.
- Zhuang WY, Wang Z. 1998a. Discomycetes of tropical China. I. Collections from Hainan Island. Mycotaxon 67: 21–31.
- Zhuang WY, Wang Z. 1998b. Discomycetes of the tropical China. II. Collections from Yunnan. Mycotaxon 69: 339–358.
- Zhuang WY, Yang ZL. 2008 [“2007”]. Some pezizalean fungi from alpine areas of southwestern China. Mycol. Montenegrina 10: 235–249.

***Scutellinia jejuensis* (Pezizales), a new species from Korea**

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Abstract – A new species of *Scutellinia* discovered in Jeju, Korea, *Scutellinia jejuensis*, is formally introduced. A combination of morphological characteristics and sequence analysis of the partial LSU rDNA demonstrates that the fungus represents a species distinct from all other subglobose to globose-spored *Scutellinia* species.

Key words – aculeolate-reticulate, Jeju Island, soil-inhabiting, subglobose ascospores

Introduction

The cosmopolitan genus *Scutellinia* (Cooke) Lambotte forms a well-defined group within the family *Pyronemataceae* (Pezizales), which contains a group of fungi characterized by a red or orange colored apothecial ascoma, clothed with stiff, brownish or black hairs along the apothecial rim (Schumacher 1990). They are presumed to be saprobic on wood and humus. Of approximately 50 species recognized in the genus, only ten are characterized by subglobose or globose ascospores, and these are all humus saprotrophs (Schumacher 1990, Yao & Spooner 1995, Liu & Peng 1996, Matočec 2000). During research on cup fungi in Korea, we found a soil-inhabiting ascomycete at Mt. Halla in Jeju Island. Based on a careful macro- and micro- observation, the fungus unequivocally belonged to *Scutellinia* and was close to *S. barlae* (Boud.) Maire 1933, *S. minor* (Velen.) Svrček 1971, *S. rotundisperma* Donadini 1983, and *S. trechispora* (Berk. & Broome) Lambotte 1887 judging by its subglobose to globose ascospores and

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aculeolate or reticulate wall sculpturing. The Korean material, however, differs from them in several aspects. We formally describe this fungus as a new species of *Scutellinia* based on morphological characteristics and sequences analysis of the D1/D2 region of LSU rDNA.

Materials and methods

Free-hand sections of the fresh materials were mounted in distilled water, lactic acid, lacto-cotton blue, and Lugol's reagent (IKI). These preparations were examined in brightfield- and DIC- light microscopy, using an Olympus BX51 microscope (Olympus, Tokyo, Japan) for observations and measurements and a Zeiss AX10 microscope (Carl Zeiss, Göttingen, Germany) mainly for photographs. Measurements were performed at 1000× for ascospores and at 100–400× for other structures; they are reported as follows; minimum-maximum (length) × minimum-maximum (width) [mean length ± standard deviation × mean width ± standard deviation, Q (l/w ratio) = average ± SD].

Genomic DNA was extracted directly from the matured apothecia by the methodology described in Lee and Taylor (1990). To raise the efficiency of extraction, the apothecia were pounded using a sterilized glass rod in the cell lysis step. Primers LR0R and LR5 (Moncalvo et al. 2000) were used for the amplification of D1/D2 region of 28S rDNA. The PCR products were purified using a QIAquick Gel Extraction Kit (Qiagen, Hilden, Germany) and sequenced on an automatic sequencer (ABI Prism™ 377 DNA Sequencer), using the BigDye™ (Applied Biosystems, Foster City, CA, USA) Cycle Sequencing Kit, version 3.1, with primers identical to those used for amplifications. Sequences were edited with the DNASTAR computer package (DNASTar, Inc., Madison, Wis.), version 5.05, and aligned using CLUSTAL X (Thompson et al. 1997). Phylogenetic trees were obtained from the data using Maximum Likelihood (ML) and Maximum Parsimony (MP). For ML inference, RAxML version 7.0.3 (Stamatakis 2006) was used with all parameters set to default values, using the GTRCAT variant. MP analysis was done using MEGA 4.0 (Tamura et al. 2007), with the default settings of the program, for which 1000 bootstrapping replicates were performed. We selected all the available sequences of *Scutellinia*, and used *Octospora leucoloma* Hedw. (DQ220380) as outgroup taxon according to the result of recent phylogenetic analysis (Perry et al. 2007).

Results

Taxonomic description

Scutellinia jejuensis J.G. Han, Y.J. Choi & H.D. Shin, sp. nov.

FIGURE 1

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Ascospores subglobosa cum ornamentum aculeolatum-reticulatum. Scutellinia minor similis, sed in sporis ornamentis non reticulatus et minusculus differt.

HOLOTYPE – on damp soil, Mulchat-oreum, Mt. Halla National Park, Jeju, Korea, 33°25'21.42"N 126°37'18.11"E, alt. 610 m, 5 XI 2008, J.G. Han, Y.J. Choi and H.D. Shin (KUS-F52411). Sequence ex-type: GU361609 for D1/D2 region of 28S rDNA.

ETYMOLOGY – the specific epithet refers to the Jeju Island of Korea where the fungus was first collected.

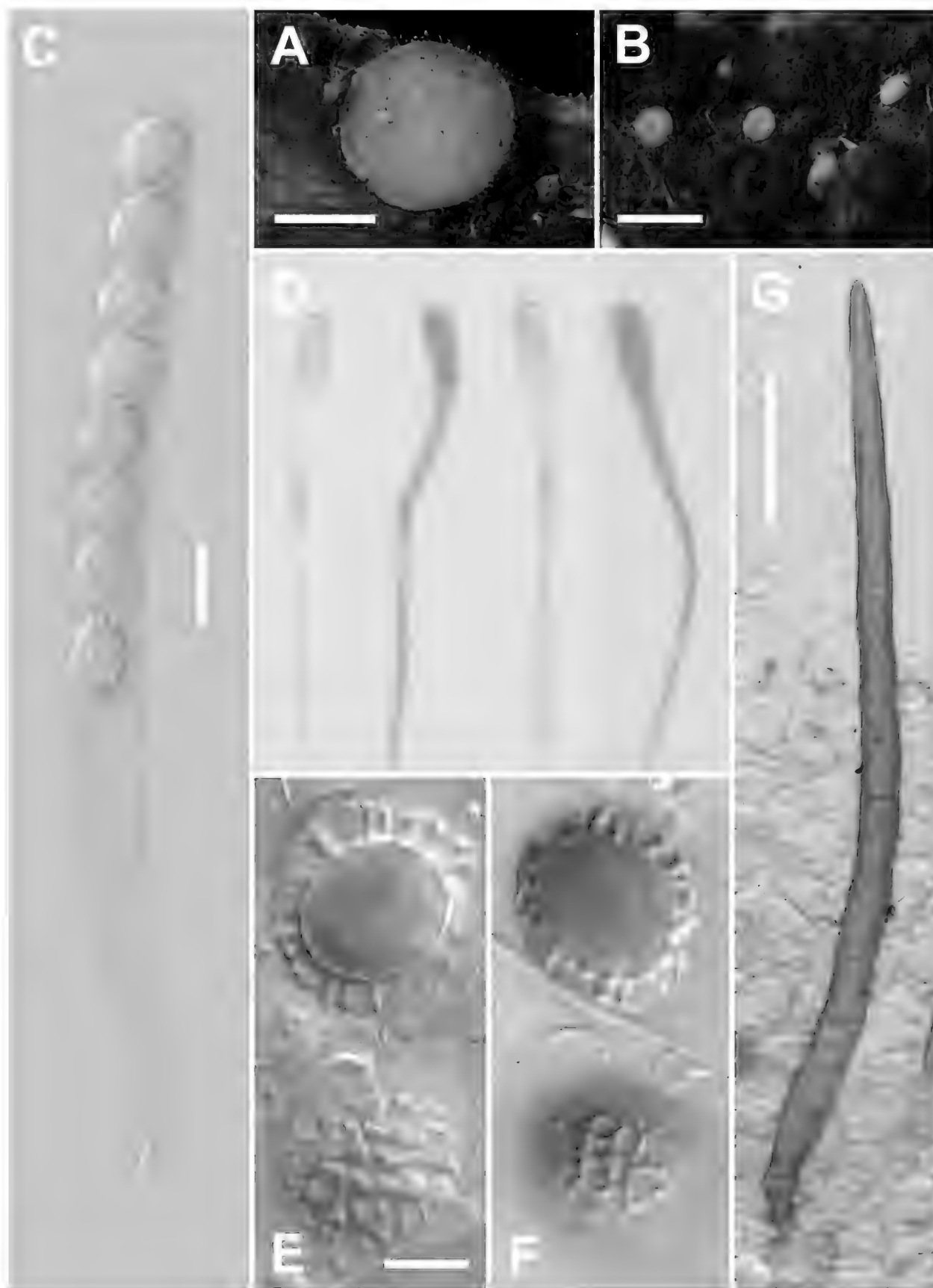


FIGURE 1. *Scutellinia jejuensis* (holotype KUS-F52411). A–B: flesh apothecia on damp soil, C: ascus, apical pore not blued in IKI, D: paraphyses, E–F: subglobose ascospores sculpturing aculeolate ornamentations, note on their interconnections, G: acuminate, thick-walled hair oriented from globose ectal cells.

Scale bars = 2 mm for A, 1 cm for B, 20 µm for C–D, 10 µm for E–F, and 100 µm for G.

APOTHECIA gregarious, almost sessile. RECEPTACLE at first globose, then becoming shallowly cupulate to discoid, light red, externally covered with short dark brown hairs. Margins concolorous with the receptacle, surrounded by dark brown hairs. DISC up to 6 mm diam., plano-convex, reddish orange to scarlet when fresh, turning yellowish orange when dry. ECTAL EXCIPULUM hyaline to yellowish, composed of textura globulosa to angularis, thin-walled, cells $43\text{--}100 \times 28\text{--}95 \mu\text{m}$. MARGINAL HAIRS not differentiated from lateral hairs, cylindric-conical, gradually narrowed to the apex, ventricose, thick-walled, walls $4\text{--}6 \mu\text{m}$ wide, brown to dark brown, with uni- or bi-furcate base, $3\text{--}11$ -septate, $190\text{--}640 \times 17\text{--}30 \mu\text{m}$. ASCI cylindric, hyaline, 8-spored, walls not becoming blue in IKI without KOH pretreatment, $255\text{--}380 \times 20\text{--}29 \mu\text{m}$ ($318.8 \pm 29.7 \times 23.9 \pm 2.7 \mu\text{m}$, $n = 26$). ASCOSPORES subglobose to globose but rarely broadly ellipsoidal when immature, hyaline, mature spores covered with ornamentations, aculeolate-reticulate, truncate-conical warts, commonly forming sinuate ridges which partly interconnect to a reticulum below, $2.5\text{--}3 \mu\text{m}$ high, $0.5\text{--}1 \mu\text{m}$ wide, uniseriate, occupying upper $1/2$ of the entire ascus length, $16\text{--}23 \times 13\text{--}19 \mu\text{m}$ ($18.7 \pm 1.4 \times 15.2 \pm 1.1 \mu\text{m}$, $Q = 1.23 \pm 0.08$, $n = 100$) (not including the ornamentation). PARAPHYSES cylindric, hyaline, septate, unbranched, $3.5\text{--}4 \mu\text{m}$, apical cells clavate, $37\text{--}69 \times 6\text{--}9 \mu\text{m}$ ($54.0 \pm 9.7 \times 8.1 \pm 0.8 \mu\text{m}$, $n = 24$), not exceeding the asci.

Phylogenetic analysis

The phylogenetic relationship among *Scutellinia* species was inferred from ML and MP analyses of the aligned sequences of the D1/D2 LSU rDNA. The result of the phylogenetic reconstructions by ML inference is shown in FIGURE 2. In the D1/D2 alignment, 86 of the 880 characters were parsimony-informative, and the parsimony analysis produced eight most parsimonious trees of 279 steps, with a CI and RI of 0.7380 and 0.6409, respectively. Since no differences were found between the tree topologies of the ML and MP analyses, only the ML tree is shown in FIGURE 2, with the addition of the support values of the MP analysis. In the phylogenetic tree, *S. jejuensis* occupied an independent branch within the genus *Scutellinia* and further formed a well-supported clade with *S. barlae*, *S. hyperborea*, and *S. trechispora* with high supporting values of 97 and 93 in ML and MP, respectively. However, sequence distances among the three species were considerable; 1.7% (15 of 880 nucleotide characters were different) to *S. barlae* and 1.6% (14 of 850) to *S. hyperborea* and *S. trechispora*.

Discussion

Up to now, ten *Scutellinia* species have been known to possess globose or subglobose ascospores, and all are found on soil (Schumacher 1990, Yao & Spooner 1995, Liu & Peng 1996, Matočec 2000). Among them, four species

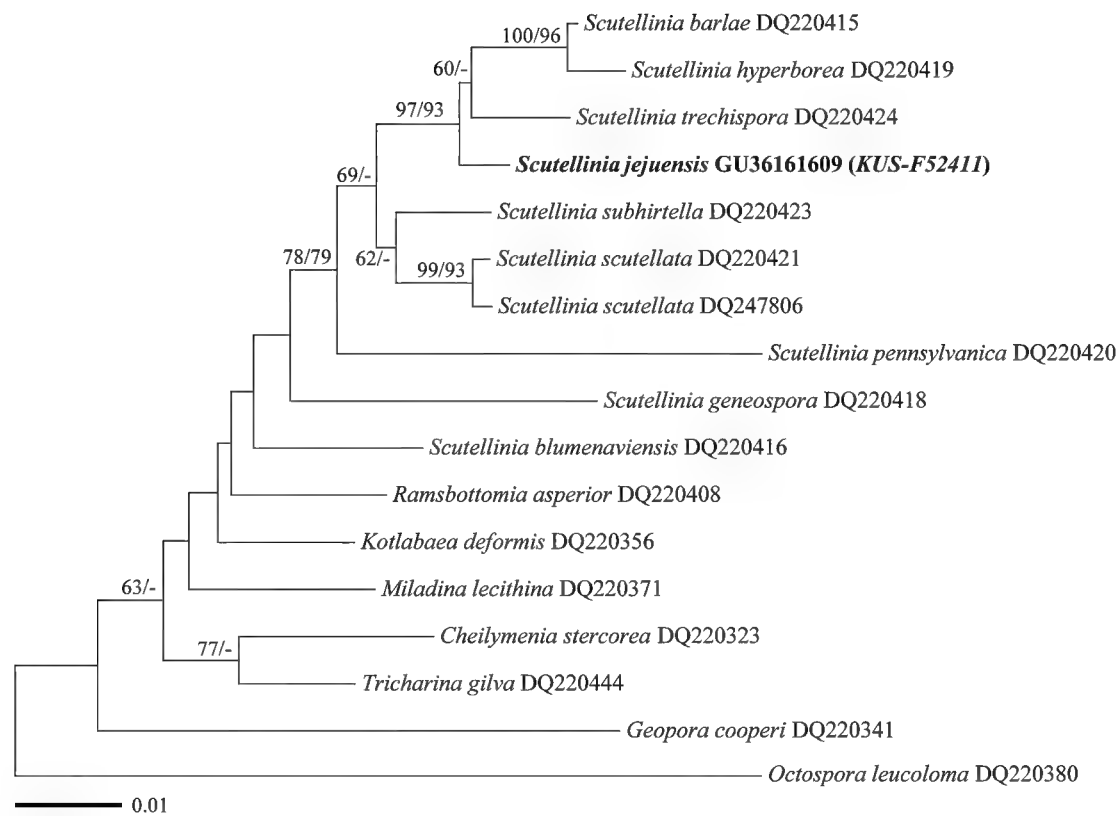


FIGURE 2. Phylogenetic tree inferred from ML analysis of the partial D1/D2 region of rDNA. Support values (ML BS/MP BS) above 50% are given above the branches. The number of nucleotide changes between taxa is represented by branch length. The scale bar equals the number of nucleotide substitutions per site. *Scutellinia jejuensis* sequence is shown in bold.

(*S. barlae*, *S. minor*, *S. rotundisperma*, *S. trechispora*) show aculeolate or reticulate sculpturing on ascospore surfaces similar to *S. jejuensis*, while in the other species the surface is tuberculate (*S. citrina* (Masse & Crossl.) Y.J. Yao & Spooner 1995, *S. hyperborea* T. Schumacher 1990, *S. paludicola* (Boud.) Le Gal 1966, *S. sinensis* M.H. Liu 1996, *S. tuberculata* Matočec 2000) or spinulose (*S. legaliae* Lohmeyer & Häffner 1983). Additionally, *S. jejuensis* differs from *S. hyperborea* in low wart height (0.5–0.8 μm) and from other species with perfectly globose spores.

Scutellinia jejuensis is not likely to be confused with the four species sharing similar spore ornamentation because of its unique morphological and molecular characteristics. The perfectly globose ascospores in *S. barlae*, *S. rotundisperma*, and *S. trechispora* easily distinguish them from the new subglobose-spored species. In addition, *S. jejuensis* differs from *S. barlae* by having more septa in marginal hairs (3–11 vs 1–4). The present species has shorter (190–640 μm) marginal hairs that are not differentiated from the lateral ones. *Scutellinia rotundisperma* and *S. trechispora* show significantly long hairs (600–1000 and

500–2060 μm , respectively). The morphological separation of *S. jejuensis* from *S. barlae* and *S. trechispora* was also clearly supported by the present phylogenetic analysis of D1/D2 region of LSU rDNA. In overlapping dimensions of marginal hairs and subglobose ascospores, *S. jejuensis* was most similar to *S. minor*. The two species can be, however, easily discriminated by several characters: the wall ornamentation is aculeolate-reticulate with often-connected warts in the new species but aculeolate with isolated warts in *S. minor*. The warts in *S. jejuensis* are larger than those in *S. minor* ($2.5\text{--}3 \times 0.5\text{--}1 \mu\text{m}$ vs $1.0\text{--}1.8 \times \text{ca. } 1.5 \mu\text{m}$), and the length/width ratio was somewhat higher. Additionally, *S. minor* shows preference to boreo-polar habitats in Europe (Schumacher 1990, 1993), while *S. jejuensis* was collected in subtropical-warm temperature zone in East Asia.

A boreo-temperate species restricted to Europe, *Scutellinia decipiens* Le Gal 1966, is somewhat closer to *S. jejuensis* in that the ascospores have broadly ellipsoidal to subglobose shape, overlapping dimensions, and somewhat reticulate with partially interconnected warts (Le Gal 1966, Schumacher 1990). However, its longer and wider marginal hairs (400–1500 and 16–35 μm , respectively) and tuberculate sculpturing separates the new species. *Scutellinia kerguelensis* (Berk.) Kuntze 1891 and *S. Chiangmaiensis* T. Schumach. 1990 also possess broadly ellipsoidal to subglobose ascospores, but they are easily discriminated from *S. jejuensis* by the smaller ($15.3\text{--}18.0 \times 11.0\text{--}13.0 \mu\text{m}$) and reticulated ascospores and the larger ($21.8\text{--}28.2 \times 14.4\text{--}21.8 \mu\text{m}$) and micro-verrucose ones, respectively.

Interestingly *S. jejuensis*, like all known *Scutellinia* species with globose to subglobose ascospores, is found on soil. Other *Scutellinia* species, those with ellipsoid ascospores, occur on well-decayed wood. This suggests that the substrate may prove to be important in understanding the diversification of *Scutellinia*. In our limited study, the taxa with globose spores also all group together or form a monophyletic group with reasonably high support. Little is known of the evolutionary history of the genus or details of the biology of these species. It might be assumed that there may have been substrate specialization followed by radiation in the evolutionary history of *Scutellinia* species.

Acknowledgments

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Literature cited

- Lee SB, Taylor JW. 1990. Isolation of DNA from fungal mycelia and single spores. 282–287, in MA Innis et al. (eds.), PCR Protocols: A guide to methods and applications. San Diego, Academic Press.
- Le Gal M. 1966. Contribution a la connaissance du genre *Scutellinia* (Cooke) Lamb. emend. Le Gal. (1re étude). Bull. Soc. Mycol. France 82: 301–334.
- Liu M, Peng H. 1996. *Scutellinia sinensis*, a new spherical-spored species of *Scutellinia*. Acta Mycologica Sinica 15: 98–100.
- Matočec N. 2000. The genus *Scutellinia* (Pezizales) in Croatia III. A new species - *Scutellinia tuberculata*. Mycotaxon 76: 481–488.
- Moncalvo JM, Lutzoni FM, Rehner SA, Johnson J, Vilgalys R. 2000. Phylogenetic relationships of agaric fungi based on nuclear large subunit ribosomal DNA sequences. Syst. Biol. 49: 278–305.
- Perry BA, Hansen K, Pfister DH. 2007. A phylogenetic overview of the family *Pyronemataceae* (Ascomycota, Pezizales). Mycol. Res. 111: 549–571.
- Schumacher T. 1990. The genus *Scutellinia* (Pyronemataceae). Opera Bot. 101: 1–107.
- Schumacher T. 1993. Ecology and distribution of the genus *Scutellinia* in Norway - Arctic and Alpine Mycology 4. Bibl. Mycol. 150: 215–233.
- Stamatakis E. 2006. RAxML-VI-HPC: maximum likelihood-based phylogenetic analyses with thousands of taxa and mixed models. Bioinformatics 22: 2688–2690.
- Tamura K, Dudley J, Nei M, Kumar S. 2007. MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. Molecular Biol. Evol. 24: 1596–1599.
- Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 24: 4876–4882.
- Yao YJ, Spooner BM. 1995. New combinations in *Melastiza* and *Scutellinia* (Pezizales). Mycotaxon 53: 467–477.

***Lactarius rupestris*—a new species from the Brazilian semi-arid region**

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Abstract — *Lactarius rupestris* is proposed as a new species from the Brazilian semi-arid region. It is characterized by the rather stout basidiome with a ochraceous salmon stipe that is up to 21 mm wide, a relatively smooth and viscid orange tinted pileus, close and frequently anastomosed lamellae, subglobose to ellipsoid basidiospores with distinct verrucae up to 0.7 µm high, a trichoderm pileipellis, and abundant sphaerocysts in the lamellar and pileus tramas.

Key words — *Agaricomycetes*, *Russulales*, neotropics, taxonomy

Introduction

The globally distributed genus *Lactarius* Pers., which with *Russula* Pers. forms the core of the family *Russulaceae*, is one of the major groups of ectomycorrhizal macrofungi. It can be identified by the basidioma exuding latex (Singer 1986) and the presence of common pseudocystidia (Miller et al. 2006).

In Brazil at least 19 taxa of *Lactarius* are known: *L. amazonensis* Singer, *L. annulifer* Singer, *L. campinensis* Singer, *L. gigasporus* Singer, *L. igapoensis* Singer, *L. mamorensis* Singer, *L. pallidipes* Singer, *L. reticulatus* (Berk.) Singer, *L. subpallidipes* Singer and *L. subreticulatus* Singer in Amazonian lowland forests (Pegler & Fiard 1979, Singer et al. 1983, Pegler 1988, Souza & Aguiar 2004); *L. deliciosus* (L.) Gray, *L. rufus* (Scop.) Fr. (these from exotic *Pinus* plantations) and *L. venezuelanus* Dennis from Paraná (Buyck & de Meijer 1999; de Meijer 2001, 2006); *L. deliciosus*, *L. rufus* and *L. russula* Rick from Rio Grande do Sul (Singer 1953, Guerrero & Homrich 1983, Singer et al. 1983, Sobestiansky 2005); *L. argillaceifolius* Hesler & A.H. Sm. var. *argillaceifolius*, *L. deliciosus*, *L. fragilis* (Burl.) Hesler & A.H. Sm. var. *fragilis*, *L. rufus* var. *parvus* Hesler & A.H. Sm. and *L. rufus* var. *rufus* in exotic *Pinus* plantation from Santa Catarina (Giachini et al. 2000, Karstedt & Stürmer as *L. cf. fragilis*); *L. hygrophoroides* Berk. & M.A. Curtis and *L. paulensis* Singer from São Paulo (Singer et al. 1983, Pegler 1997).

Here we describe a new species of *Lactarius* from the Brazilian semi-arid region, collected in the National Park of Catimbau, located in the ecoregion of the caatinga biome called “Planalto da Borborema” (Velloso et al. 2002) in an area characterized as “campo rupestre,” which commonly occurs at 900–1000 m alt. (Rodal et al. 1998). In this area, members of *Apocynaceae*, *Bignoniaceae*, *Erythroxylaceae*, *Euphorbiaceae*, *Lauraceae*, *Fabaceae*, *Malpighiaceae*, *Myrtaceae*, *Polygonaceae*, *Rubiaceae*, *Sapindaceae*, *Simaroubaceae*, *Solanaceae*, *Trigonaceae*, *Turneraceae*, and *Verbenaceae* are commonly found (Rodal et al. 1998, Andrade et al. 2004, Gomes et al. 2006).

Materials and methods

For microscopic analyses 3% KOH and Melzer’s reagent were used and terminology for microstructures follows Verbeken (1998a). Colors of basidiomes were observed in fresh material, and color coding follows Online Auction Color (2004). Presentation of basidiospore data follows the methodology proposed by Tulloss et al. (1992) where the notation “[a/b/c]” at the beginning of the spore data set is to be read “a spores measured from b basidiomes taken from c collections.” Other abbreviations include L(W) = basidiospore length (width) average from a single basidiome, Q = the length : width ratio range as determined from all measured basidiospores, and \bar{Q} = the Q value averaged from all basidiospores measured within a single basidiome. The holotype of *L. rupestris* is deposited in the Herbarium of the Mycology Department of the “Universidade Federal de Pernambuco” (URM).

Taxonomy

Lactarius rupestris Wartchow, sp. nov.

FIG. 1–5

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Pileus 60–70 mm, concavus-subinfundibuliformis, depressus, margine regulari, subviscosus, brunneo-aurantius ad flavidum in margine. *Lamellae* subdecurrentes, confertae, ochraceae, salmonescentes. *Stipes* 35–45 × 18–21 mm, subcylindratus, pallide ochraceus salmonescens. *Latex* cremeous, haud abundantibus. *Basidiosporae* (6.5–)7–8.5(–9) × (5.5–)6–7(–7.5) μm late ellipsoideae, subreticulatae, cristis usque ad 0.3–0.7 μm altis ornatae, macula suprahilaris non amyloidea. *Basidia* 35–50 × 8–11 μm , clavata, tetraspora. *Pleurocystidia* absentia. *Pleuropseudocystidia* rara. *Pileipellis* trichoderma, cellulae terminales 20–51 × 4–6 μm , subfusiformes, clavatae vel subcylindricae, tenuitunicatae; subpellis hyphis angustis.

TYPE: Catimbau National Park (“Trilha do Camelo”), Buíque, Pernambuco, Brazil, 23 July 2007 **Holotype**: F. Wartchow 15/2007 (URM 80214), preserved in a phormol-acetic acid-alcohol solution.

PILEUS 60–70 mm, concave-subinfundibuliform, somewhat umbilicate, orange (OAC 763) at center to brownish orange towards margin (OAC 694, OAC 715), moderately viscid, smooth to somewhat cracking, very indistinctly tomentose; margin entire, not striate neither sulcate, slightly involute. LAMELLAE short decurrent, cream-salmon (OAC 766–767), crowded to most frequently sub-

crowded, up to 3 mm broad, frequently dichotomously branching in several lengths; margin smooth, concolorous; lamellulae frequent, with diverse lengths. STIPE 35–45 × 18–21 mm, central, cylindrical, slightly tapering near the base, pale ochraceous salmon (OAC 763), with short decurrent lines at upper surface near to lamellae attachment, longitudinally slightly ribbed (only under lens). CONTEXT spongy, pale yellow ochraceous (OAC 793–794) in pileus, cream yellow (OAC 793) in stipe. LATEX cream-colored to more or less concolorous with lamellae, not abundant.

BASIDIOSPORES [25/1/1] (6.5–)7–8.5(–9) × (5.5–)6–7(–7.5) µm (L = 7.8 µm, W = 6.3 µm, Q = (1.13–)1.16–1.34(–1.39), Q = 1.24), broadly ellipsoid to ellipsoid, occasionally subglobose; ornamentation amyloid, finely verrucose with each wart ranging to 0.5–0.7 µm high, interconnected by fine line, but never forming a complete reticulum; hilar appendix narrowly obtuse to subconical to conical; plage not very distinct, but with amyloid spot. BASIDIA 35–50 × 8–11 µm, clavate, bearing mainly four, but sometimes two very long (6–10 µm long) sterigmata. PSEUDOPLEUROCYSTIDIA very scarce, 170 × 24 µm long, with brownish refractive contents, thin-wall, arising from deep in the hymenophoral trama. LAMELLA EDGE sterile, with MARGINAL CELLS 30–45 × 4–6 µm, cylindrical somewhat sinuous, thin-walled, hyaline. PILEUS CONTEXT with abundant sphaerocysts 25–65 × 24–50 µm, globose or nearly so; filamentous hyphae up to 10 µm wide; lactiferous hyphae common, up to 15 µm broad, with a longitudinal orientation, somewhat diverging from trama, but not forming projecting pseudocystidia. SUBHYMENIUM with clavate, inflated clavate to nearly subglobose cells 16–27 × 9–17 µm. HYMENOPHORAL TRAMA heteromerous, with abundant nearly isodiametric (17–25 × 13–18 µm) cells, filamentous hyphae 3.5–6.5 µm; lactiferous hyphae frequent, up to 7–12 µm broad, straight and only occasionally branching. PILEIPELLIS a trichoderm up to 140 µm thick, two layered; elements of suprapellis 20–51 × 4–6 µm, plentiful, colorless, thin-walled somewhat thickening up to 0.5 µm, obtuse, subacute to infrequently subcapitate or pyriform; subpellis composed of plentiful hyphae of 3–8 µm wide and somewhat more inflated cells to 10–18 µm wide, colorless. Clamp-connections absent in all tissues examined.

HABITAT: buried with up to 2/3 of the stipe in sandy soil near several shrubs (*Fabaceae* subfam. *Mimosoideae* and others) in a semi-arid region, after heavy precipitation.

DISTRIBUTION: Known only from the type locality.

REMARKS: *Lactarius rupestris* is characterized by the rather stout basidiome with an ochraceous salmon stipe that is up to 21 mm wide, a relatively smooth pileus with orange tints when fresh, close and frequently anastomosed lamellae,

broadly ellipsoid to ellipsoid basidiospores that are distinctly verrucose with ornamentation up to 0.7 μm high, a trichodermial pileipellis with a suprapellis of erect thin-walled elements, and a cellular pileus trama. Its presence in the Brazilian semi-arid makes it unique among the *Lactarii*.

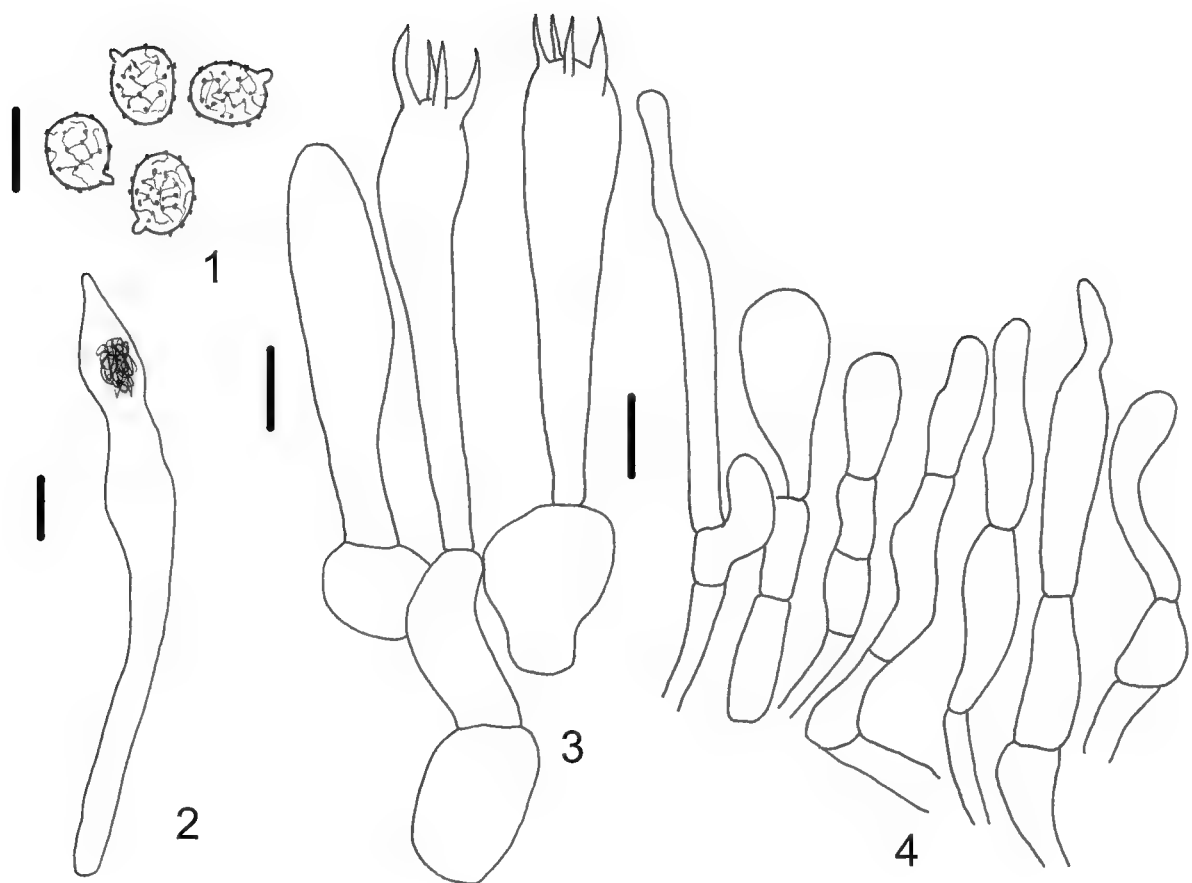
According to the key in Verbeken (2001), the lack of annulus, unchanging context, relatively smooth (neither pruinose nor truly tomentose) pileus, pale basidiospores with interconnected low spines, non-zonate pileus, entire lamellar edge, stout basidioma, non-palisade type pileipellis structure, and absence of thick-walled dermatolamprocystidia support placement of *L. rupestris* into *Lactarius* sect. *Edules* Verbeken. However, the frequently aerolate, relatively dry pileus surface and less ornamented basidiospores cited in the protologue for sect. *Edules* by Verbeken & Walley (1999) does not fit our new species. This section remains unclassified at the subgenus level, and Verbeken & Walley (1999) and Buyck et al. (2007) report that it would probably be elevated to subgenus after more research on a global scale (Buyck et al. 2007).

Verbeken (2001) includes at least six tropical African species in this section, among which four also have the crowded lamellae and somewhat similar basidiospore size found in *L. rupestris*: *Lactarius densifolius* Verbeken & Karhula, *L. inversus* Gooss.-Font. & R. Heim, *L. phlebophyllus* R. Heim, and *L. nodosicystidiosus* Verbeken & Buyck. All four differ from *L. rupestris* in their lower basidiospore ornamentation and dry cracking aerolate pileus, distinctive features of these African taxa (Verbeken & Walley 1999, Buyck et al. 2007).

In the Verbeken (2001) key, *Lactarius* sect. *Chamaeleontini* Verbeken, characterized by a smooth pileus, contains one species, *L. laevigatus* Verbeken, with a trichoderm pileipellis without thick-walled elements, features that differ from the rest of this section (Verbeken 1998b). However, the strongly striate, deeply sulcate pileus margin that characterizes this section (Verbeken 1998b) is lacking in *L. rupestris*; furthermore, the ornamentation of *L. laevigatus* basidiospores does not exceed 0.2 μm (Verbeken 1996).

We regard *L. rupestris* as a rather isolated species that does not fit entirely into any tropical infrageneric taxon proposed by Verbeken (2001). Its slightly moist, non-aerolate pileus and relatively high basidiospore ornamentation separate our new species from *L.* sect. *Edules* as well as from *L. laevigatus* of sect. *Chamaeleontini*.

Different infrageneric arrangements exist for *Lactarius* outside the sections discussed above (Verbeken 1998b, 2001). The occurrence of abundant subisodiametric to sphaerocystidioid cells in the lamellar trama of *Lactarius rupestris* also characterizes *L.* sect. *Polisphaerophori* Singer. Montoya et al. (2007), however, recently transferred the type species of the section — *L. verae-crucis* Singer (Pegler & Fiard 1979, Singer et al. 1983, Singer 1986) — to



FIGS. 1–4. *Lactarius rupestris* (from holotype).
1. Basidiospores. 2. Pleuropseudocystidium. 3. Basidia, basidiole and subhymenium.
4. Terminal elements of the pileipellis.
Scale bar = 10 μ m (FIGS. 1,3,4) & 20 μ m (FIG. 2)

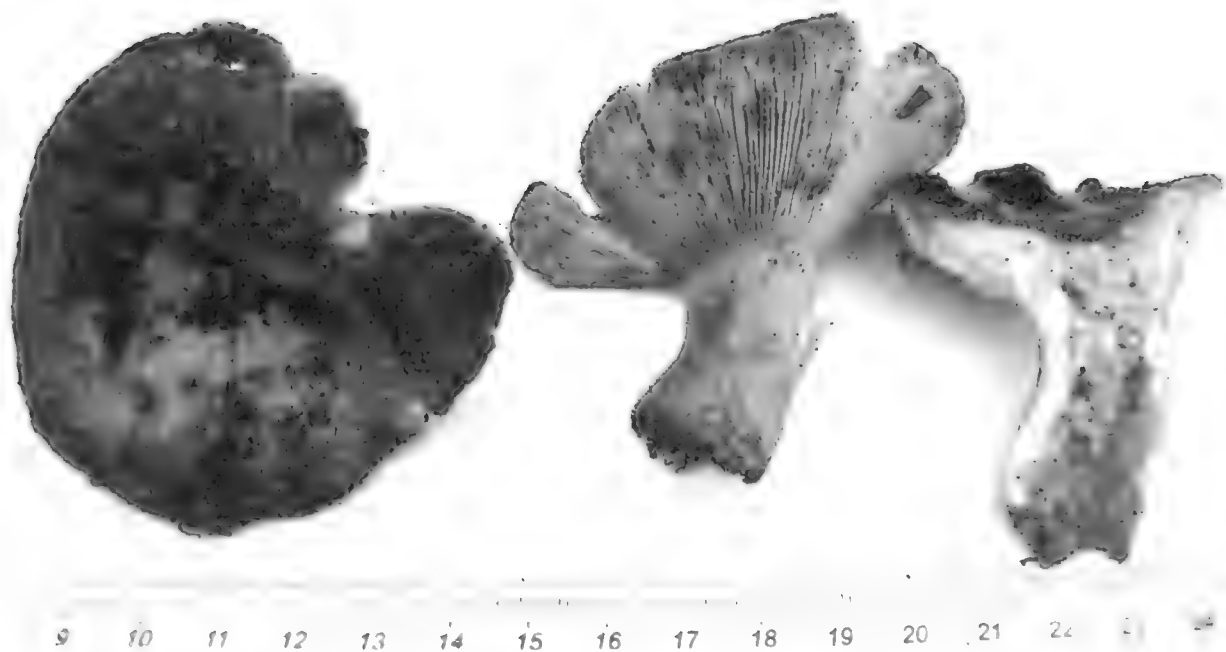


FIG. 5. *Lactarius rupestris* (from holotype). Basidiomes.
Photo by E.R. Drechsler-Santos.

subgenus *Lactiflui* (Burl.) Hesler & A.H. Sm. emend Verbeken based on similar basidiome color, distant lamellae, basidiospore morphology, and possession of a pseudoparenchymatous pileipellis with thick-walled lamprocystidia shared with *L. luteopus* Verbeken.

A previous comparison of a Brazilian collection with the holotype of *L. venezuelanus* (a species from Venezuela also classified in *Polisphaerophori* by Pegler & Fiard, 1979), showed that *L. venezuelanus* should be referred to subgenus *Lactariopsis* (Henn.) R. Heim sect. *Chamaeleontini* (Buyck & de Meijer 1999) due to presence of thick-walled lamprocystidia and the well developed underlying pseudoparenchymatous layer and the absence of veil and macrocystidia. Such analyses suggest that sect. *Polisphaerophori* is rather artificial, and detailed morphological and molecular analyses are needed before classifying new world taxa at an infrageneric level.

Lactarius rupestris differs from the other taxa in sect. *Polisphaerophori* with a brightly colored (but not yellow) pileus and distinctly pigmented stipe covered by Singer et al.'s (1983: 294) key as follows:

The Amazonian *L. mamorensis* is differentiated by a conspicuously ribbed and slender (≤ 13 mm diam) stipe, with each rib somewhat anastomosing, a mature pileus that is tuberculate-sulcate or transparently striate, and a pileipellis composed of upright chains of 2–4 sphaerocysts forming a short epithelium at the base of the thin walled dermatocystidia (Singer et al. 1983).

Lactarius paulensis, from the State of São Paulo, differs from *L. rupestris* in the much more slender (≤ 8 mm diam) stipe, short-sulcate pileus margin, reddish brown to brownish cinnamon pileus color, and larger ($8.5\text{--}10 \times 7\text{--}9 \mu\text{m}$) basidiospores (Singer et al. 1983). The pileipellis of this species was described as having erect dermatocystidioid elements with thin or slightly thickened (to $1 \mu\text{m}$) walls that arise from a subpellis consisting of a shallow and often discontinuous layer of sphaerocysts and more elongated elements, and some crenate in outline (Singer et al. 1983). These cells might be interpreted as a trichopalisade pileipellis, on which a distinct layer is never formed, with generally ascending, anticlinal elements that are inflated or almost rounded and terminal elements that arise from these elements (Verbeken 1998a).

Lactarius rupestris was collected with more than 2/3 of its stipe buried in the sandy soil in “campos rupestres”. A similar pattern was recently observed with *Amanita lippiae* Wartchow & Tulloss also collected from this forest vegetation type where one of the basidiomes was completely hypogeous (Wartchow et al. 2009).

Other Brazilian *Lactarius* species are known from campina, campinarana, and periodically inundated Igapó forests from Amazonas, North Brazil, where the plants (mostly shrubs) are adapted to sandy nutrient-poor soils (Singer

& Araújo 1979, Singer et al. 1983, Singer & Aguiar 1986). Lleras & Kirkbride (1978) named this type of forest the “Amazonian caatinga”.

The “campos rupestres” are open, dry forests that occur commonly at 900–1000 m alt. (Rodal et al. 1998). Actually, *L. rupestris* is not the only species restricted to dry open forests. Verbeken & Buyck (2002) observed a relatively high phytogeographical and ecological specificity for several taxa (mainly *Lactarius*) of ectomycorrhizal fungi that are found in open (miombo, *Uapaca* woodland) or dense forest types (e.g., rain-, riparian, gallery swamp, dry evergreen forest). Pegler & Fiard (1979) concluded that in the Lesser Antilles *Lactarius* is largely restricted to dry and semi dry forests accompanying putative ectotrophic forest trees [e.g., *Pisonia fragrans* (Nyctaginaceae), *Coccoloba diversifolia* (Polygonaceae)].

The “campos rupestres” where *Lactarius rupestris* was collected also contains members of putative ectomycorrhizal tree families (sensu Singer & Araújo 1979, Singer et al. 1983), such as *Euphorbiaceae*, *Fabaceae* (all three subfamilies), *Myrtaceae*, *Nyctaginaceae*, and *Polygonaceae* (Rodal et al. 1998, Andrade et al. 2004, Gomes et al. 2006). Due to this high plant diversity, it is difficult to identify for certain the putative mycorrhizal associate of *L. rupestris*, and so it becomes necessary to record all potential hosts within a 20 m radius. Taylor & Alexander (2005) note that it is virtually impossible to identify a host solely based on where the basidiome is collected and that choosing the nearest tree species as the host could be very misleading.

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Literature cited

- Andrade KVSA, Rodal MJN, Lucena MFA, Gomes APS. 2004. Composição florística de um trecho do Parque Nacional do Catimbau, Buíque, Pernambuco-Brasil. *Hoehnea* 31: 337–348.
- Buyck B, de Meijer AAR. 1999. *Russula obtusopunctata*, a new synonym for *Lactarius venezuelanus*. *Mycotaxon* 73: 267–273.
- Buyck B, Verbeken A, Eberhardt U. 2007. The genus *Lactarius* in Madagascar. *Mycol. Res* 111: 787–798.
- Giachini AJ, Oliveira VL, Castellano MA, Trappe JA. 2000. Ectomycorrhizal fungi in *Eucalyptus* and *Pinus* plantations in southern Brazil. *Mycologia* 92: 1166–1177.

- Gomes APS, Rodal MJN, Melo AL. 2006. Florística e fitogeografia da vegetação arbustiva subcaducifólia da Chapada de São José, Buíque, PE, Brasil. *Acta Bot. Bras.* 20 : 37–48.
- Karstedt F, Stürmer SL. 2008. *Agaricales* em áreas de Floresta Ombrófila Densa e plantações de *Pinus* no Estado de Santa Catarina, Brasil. *Acta. Bot. Bras.* 22: 1036–1043.
- Lleras E, Kirkbride Jr JH. 1978. Alguns aspectos da vegetação da Serra do Cachimbo. *Acta Amazonica* 8: 51–65.
- de Meijer AAR. 2001. Mycological work in the Brazilian state of Paraná. *Nova Hedwigia* 72: 105–159.
- de Meijer AAR. 2006. A preliminary list of the macromycetes from the Brazilian State of Paraná. *Bol. Mus. Bot. Municipal (Curitiba)* 68: 1–55.
- Miller SL, Larsson E, Larsson K-H, Verbeken A, Nuytinck J. 2006. Perspectives in the new *Russulales*. *Mycologia* 98: 960–970.
- Montoya L, Bandala VM, Mata M. 2007. Studies on *Lactarius*: two new records from Costa Rica and additional information from Mexico. *Mycotaxon* 99: 279–290.
- Online Auction Color. 2004. Online Auction Color Chart. Online Auction Color Chart Co., Stanford.
- Pegler DN. 1988. *Agaricales* of Brazil described by M.J. Berkeley. *Kew Bull.* 43: 453–473.
- Pegler DN. 1997. The Agarics of São Paulo, Brazil. Kew Publishing, Kew.
- Pegler DN, Fiard JP. 1979. Taxonomy and ecology of *Lactarius* in the Lesser Antilles. *Kew Bull.* 33: 601–628.
- Rodal MJN, Andrade KVA, Sales MF, Souza APS. 1998. Fitossociologia do componente lenhoso de um refúgio vegetacional no município de Buíque, Pernambuco. *Rev. Bras. Biol.* 58: 517–526.
- Singer R. 1953. Type studies on *Basidiomycetes*. VI. *Lilloa* 26: 57–159.
- Singer R. 1986. The *Agaricales* in Modern Taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein.
- Singer R, Aguiar IA. 1986. Litter decomposing and ectomycorrhizal *Basidiomycetes* in na Igapó Forest. *Pl. Syst. Evol.* 153: 107–117.
- Singer R, Araujo IJS. 1979. Litter decomposing and ectomycorrhiza in Amazonian forests. 1. A comparison of litter decomposing and ectomycorrhizal *Basidiomycetes* in latosol-terra-firme rain forest and white podzol campinarana. *Acta Amazonica* 9: 25–41.
- Singer R, Araújo IJS, Ivory MH. 1983. The ectotrophically mycorrhizal fungi of the Neotropical Lowlands, especially central Amazônia. *Beih. Nova Hedw.* 77: 1–352.
- Sobestiansky G. 2005. Contribution to a macromycete survey of the States of Rio Grande do Sul and Santa Catarina in Brazil. *Braz. Arch. Biol. Technol.* 48: 437–457.
- Souza HQ, Aguiar IJA. 2004. Diversidade de *Agaricales* (*Basidiomycota*) na Reserva Biológica Walter Egler, Amazonas, Brasil. *Acta Amazonica* 34: 43–51.
- Taylor AFS, Alexander I. 2005. The ectomycorrhizal symbiosis: life in the real world. *Mycologist* 19: 102–112.
- Tulloss RE, Ovrebo CL, Halling RE. 1992. Studies on *Amanita* (*Amanitaceae*) from Andean Colombia. *Mem New York Bot Gard* 66: 1–46.
- Velloso HP, Sampaio EVSB, Pareyin FCG. 2002. Ecorregiões Propostas para o Bioma Caatinga. APN/TNC, Recife.
- Verbeken A. 1996. New taxa of *Lactarius* (*Russulaceae*) in tropical Africa. *Bull. Jard. Bot Nat. Belg.* 65: 197–213.
- Verbeken A. 1998a. Studies in tropical African *Lactarius* species. 5. A synopsis of the subgenus *Lactifluus* (Burl.) Hesler & A.H. Sm. emend. *Mycotaxon* 66: 363–386.
- Verbeken A. 1998b. Studies in tropical African *Lactarius* species. 6. A synopsis of the subgenus *Lactariopsis* (Henn.) R. Heim emend. *Mycotaxon* 66: 387–418.

- Verbeken A. 2001. Studies in tropical African *Lactarius* species. 10. Infrageneric classification. *Mycotaxon* 77: 435–444.
- Verbeken A, Buyck B. 2002. Diversity and Ecology of Tropical Ectomycorrhizal Fungi in Africa. In: Watling R, Frankland JC, Ainsworth AM, Isaac S, Robinson CH (eds). *Tropical Mycology*. Vol. 1. Macromycetes. CAB International, Wallingford.
- Verbeken A, Walley R. 1999. Studies in tropical African *Lactarius* species. 7. A synopsis of the section *Edules* and a review on the edible species. *Belgian J. Bot.* 132: 175–184.
- Wartchow F. 2009. *Volvariella cubensis*: a rare neotropical agaric new to South America. *Mycotaxon* 107: 181–187.
- Wartchow F, Tulloss RE, Cavalcanti MAQ. 2009. *Amanita lippiae*—a new species from the semi-arid caatinga region of Brazil. *Mycologia*: 864–870.

***Anaselenosporella sylvatica* gen. & sp. nov.
and *Pseudoacrodictys aquatica* sp. nov.,
two new anamorphic fungi from Mexico**

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Abstract — *Anaselenosporella sylvatica* anam. gen. & sp. nov. found on dead leaves of an unidentified plant and *Pseudoacrodictys aquatica* found on a decaying twig submerged in a stream, both in Veracruz, Mexico, are described and illustrated. The former is distinguished by fasciculate, macronematous, dichotomous branched, brown conidiophores, and polyblastic, sympodially proliferating conidiogenous cells with flat to slightly convex and obscure loci. The conidia are solitary, unicellular, acicular, semicircular, and curved to uncinatate. The latter is characterized by sub-involute or imbricate, globose to irregular, dark brown to black conidia.

Key words — aquatic fungi, conidial fungi, cloud forest, systematics

Introduction

During two expeditions in 1999 in a cloud forest, “Las Cañadas”, and in 2002 in several undisturbed rainforests of “Los Tuxtlas”, Veracruz, Mexico, two interesting anamorphic fungi were collected, one on decaying leaves in leaf litter and the other on a submerged decaying twig in a stream. These fungi were distinctly different morphologically from any previously described anamorphic fungi and are therefore described as new taxa.

Materials and methods

Samples of submerged plant material in a stream were collected during expeditions in 2002 through the rainforest “Los Tuxtlas”, and in 1999 in a cloud forest, “Las Cañada”, all in Veracruz State, Mexico. Individual collections were placed in paper bags and taken to the laboratory as described by Castañeda (2005), then incubated in Petri dishes at 25°C placed in a moist chamber composed of plastic containers (50 L capacity) with 200 mL of sterile water plus 2 mL of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 mL of water, plus 5 mL of glycerol) and measurements made at a magnification of $\times 1000$. Micrographs were obtained with a Zeiss Axioskop 40 microscope.

Taxonomy

Anaselenosporella Heredia, R.F. Castañeda & R.M. Arias, **anam. gen. nov.**

MYCOBANK MB 515452

Fungus anamorphicus. COLONIAE in substrato naturali pilosae, effusae, brunneae vel nigrae. Mycelium partim superficiale et partim in substrato immersum. CONIDIOPHORA macronemata, mononemata, ramosa, erecta vel prostrata, septata, laevia vel verrucosa, ferruginea vel brunnea. CELLULAE CONIDIOGENAE polyblasticae, lageniformes, cylindricae ad usque subulatae, discretiae, indeterminatae cum proliferationibus holoblasticis sympodialibus. Loci conidiogeni complanati, lentiformes vel convexi, laterales et apicales. SECESSIO CONIDIORUM schizolytica. CONIDIA solitaria, acicularia, filiformia, fusiformia vel semicircularia, unicellularia, hyalina, laevia vel verruculosa, sicca vel tenuitunicata. Teleomorphosis ignota.

SPECIES TYPICA: *Anaselenosporella sylvatica* Heredia, R.F. Castañeda & R.M. Arias

ETYMOLOGY: Greek, *Ana-*, meaning upwards, back and again; Latin, *-selenosporella*, referring to a hyphomycete genus *Selenosporella*.

Anamorphic fungi. COLONIES on the natural substratum effuse, hairy, brown or black. MYCELIUM superficial and immersed. CONIDIOPHORES macronematous, mononematous, erect or prostrate, septate, smooth or verruculose, brown. CONIDIOGENOUS CELLS polyblastic, lageniform, cylindrical to subulate, indeterminate with holoblastic sympodial proliferations, discrete. CONIDIAL SECESSION schizolytic. Conidiogenous loci flattened, lenticular or convex, lateral

and apical, slightly melanized. CONIDIA solitary, acicular, filiform, fusiform to semi-circular, unicellular, hyaline, smooth or verruculose, dry or hygroscopic. Teleomorph unknown.

COMMENTS. The genera *Selenosporella* G. Arnaud ex MacGarvie (Castañeda et al. 2009) and *Selenosporopsis* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1991) can be compared with *Anaselenosporella* in conidial ontogeny and shape, particularly in terms of the sympodial proliferation of conidiogenous cells of the main body. There are, however, clear differences in the ramification and distinctive compact cluster formed by the conidiogenous cells of *Anaselenosporella*. The conidiogenous loci in *Selenosporella* and *Selenosporopsis* are short and long denticulate respectively, whereas they are flattened or somewhat convex and slightly melanized, producing conidia truncate at the base in *Anaselenosporella*. Although conidiogenous cells of *Amphophialis*, *Sporendocladia*, *Stylaspergillus*, *Thysanophora*, and *Veramyces* are arranged in a similar compact cluster, the pattern of proliferation of the conidiogenous cell is enteroblastic and a succession of conidia are produced through each conidiogenous locus.

***Anaselenosporella sylvatica* Heredia, R.F. Castañeda & R.M. Arias, sp. nov.**

MYCOBANK MB 515453

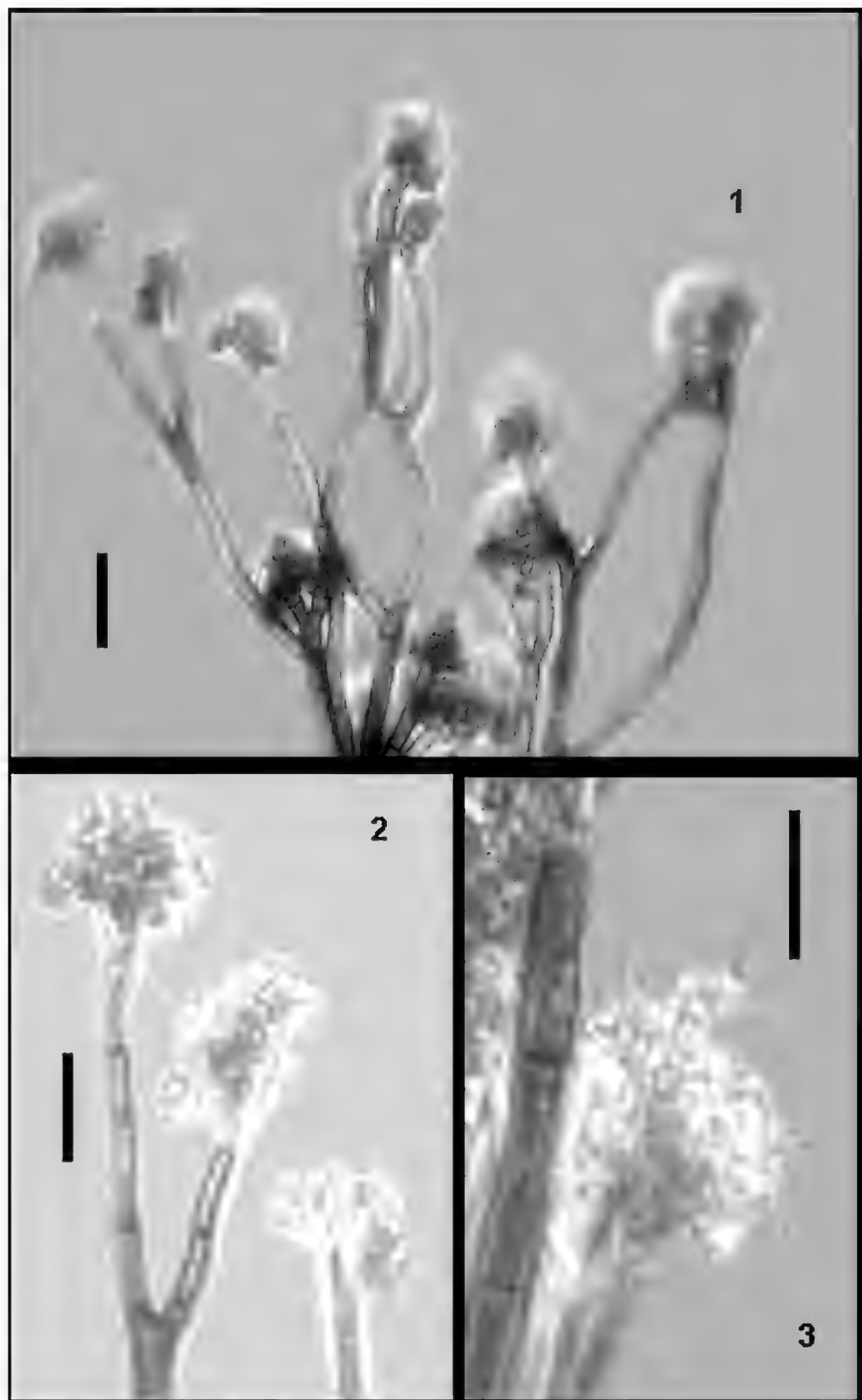
FIGS 1–8

COLONIAE in substrato naturali pilosae, effusae, atrobrunneae. Mycelium partim superficiale et partim in substrato immersum, ex hyphis septatis ramosis, brunneis, 2–4 μm diam compositum. CONIDIOPHORA macronemata, mononemata, saepissime dichotome ramosa, erecta, multiseptata, luxuriantia, 700–1200 μm alta, 12–28 μm crassa prope basim, laevia, ferruginea vel atrobrunnea sed saepe leviter brunnea vel lurida punctata vel guttata, dilute brunnea vel pallidiora ad apicem. CELLULAE CONIDIOGENAE polyblasticae, lageniforme, interdum leviter geniculatae ad apicem, indeterminatae cum proliferationibus holoblasticis sympodialibus, discretiae, compactae, fasciculatae, subhyalinae, 5–10 \times 2.0–2.5 μm , ex ramis metuloides, cuneiformibus, 3.0–4.5 μm crassis, orientes. Loci conidiogeni complanati vel lentiformes, laterales et apicales, leviter maculati. SECESSIO CONIDIORUM schizolytica. CONIDIA solitaria, acicularia, curvata ad usque semicircularia, unicellularia, truncata ad basim, hyalina, 7–12(–15) \times 0.8–1.2 μm , laevia, tenuitunicata, interdum in massa alba congregata. Teleomorphosis ignota.

TYPE: 6 km from Huatusco, “Las Cañadas”, Veracruz, Mexico, on decaying leaves of an unidentified plant, 20.V.1999. G. Heredia & R.M. Arias (Holotype: MUCL 45630).

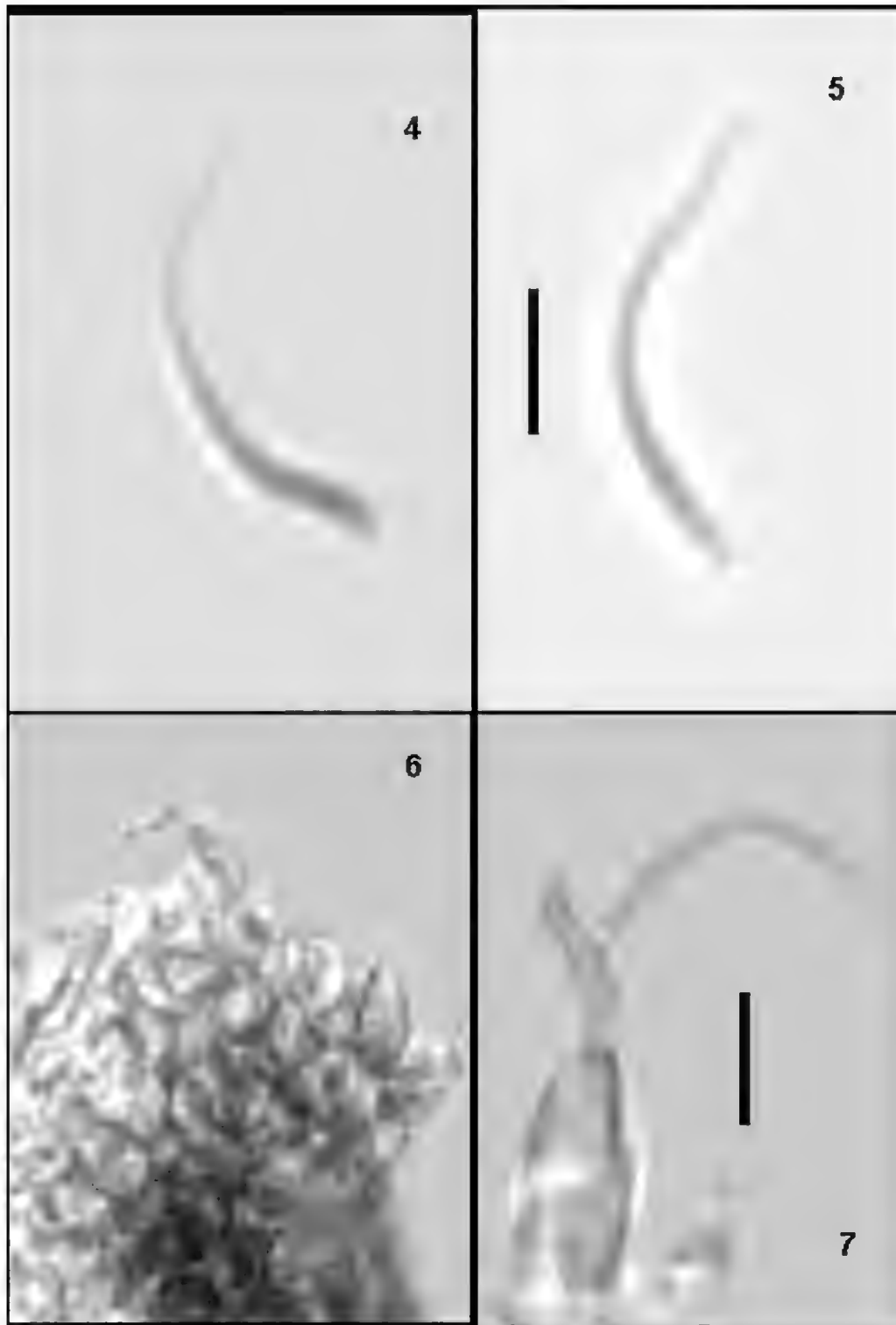
ETYMOLOGY: Latin, *sylvatica* – meaning growing wild.

COLONIES on the natural substrate effuse, hairy, amphigenous, dark brown. MYCELIUM superficial and immersed; hyphae septate, branched, 2–4 μm diam, smooth-walled, brown. CONIDIOPHORES macronematous, mononematous, dichotomously branched, erect, straight or flexuous multi-septate, smooth-walled, luxurious, 700–1200 \times 12–28 μm , dark brown at the base, rusty to dark brown, but dotted with pale brown or lurid round spots across the length and



FIGS 1–3. *Anaselenosporella sylvatica*, photographs from holotype (MUCL 45630).
Conidiophores, conidiogenous cells, and conidia.
Scale is indicated by bars: FIG. 1 = 100 μm ; FIG. 2 = 50 μm ; FIG. 3 = 10 μm .

pale brown or subhyaline towards the apex. CONIDIOGENOUS CELLS polyblastic, lageniform, slightly geniculate and elongated towards the apex, 5–10 \times 2.0–2.5 μm , indeterminate, sympodial proliferating, discrete, formed in a compact



FIGS 4–7. *Anaselenosporella sylvatica*, photographs from holotype (MUCL 45630).

4–5. Conidia. 6–7. Conidiogenous cells and conidium.

Scale is indicated by bars = 5 μm .

cluster on cuneiform, 3.0–4.5 μm wide metula-like branches. Conidiogenous loci flattened to slightly lenticular or convex and obscure (melanized), lateral and apical. CONIDIAL SECESSION schizolytic. CONIDIA solitary, acicular, curved to semicircular, unicellular, truncated at the base, hyaline, 7–12(–15) \times 0.8–1.2 μm , smooth, hygroscopic or slightly tunicate, sometimes forming white mucilaginous masses. Teleomorph unknown.

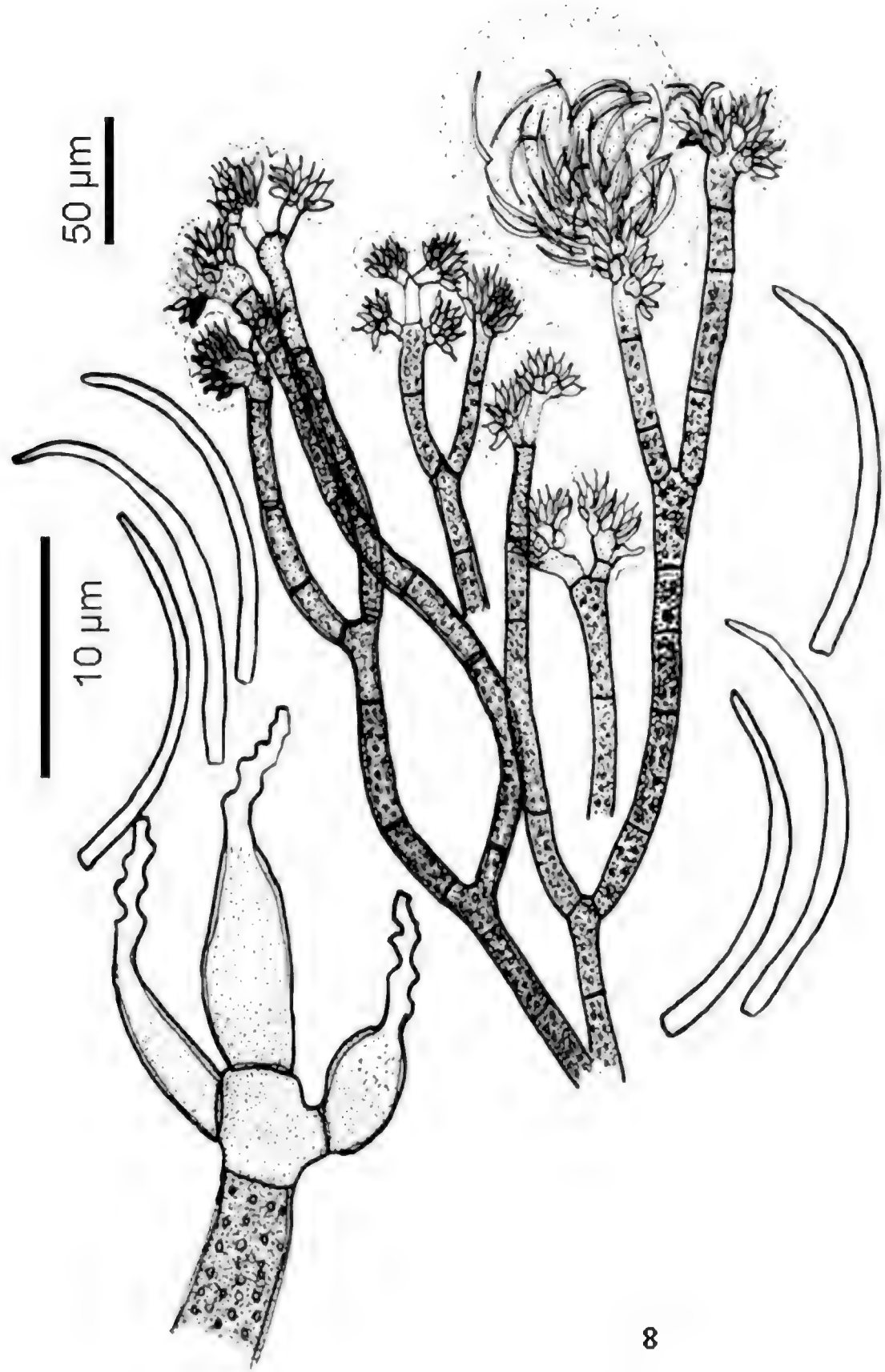


FIG. 8. *Anaselenosporella sylvatica*, drawings from holotype (MUCL 45630).
Conidiophore, conidiogenous cells, and conidia.
Scale is indicated by bars.

Pseudoacrodictys aquatica R.F. Castañeda, R.M. Arias & Heredia, sp. nov.

MYCOBANK MB 515454

FIGS 9–16

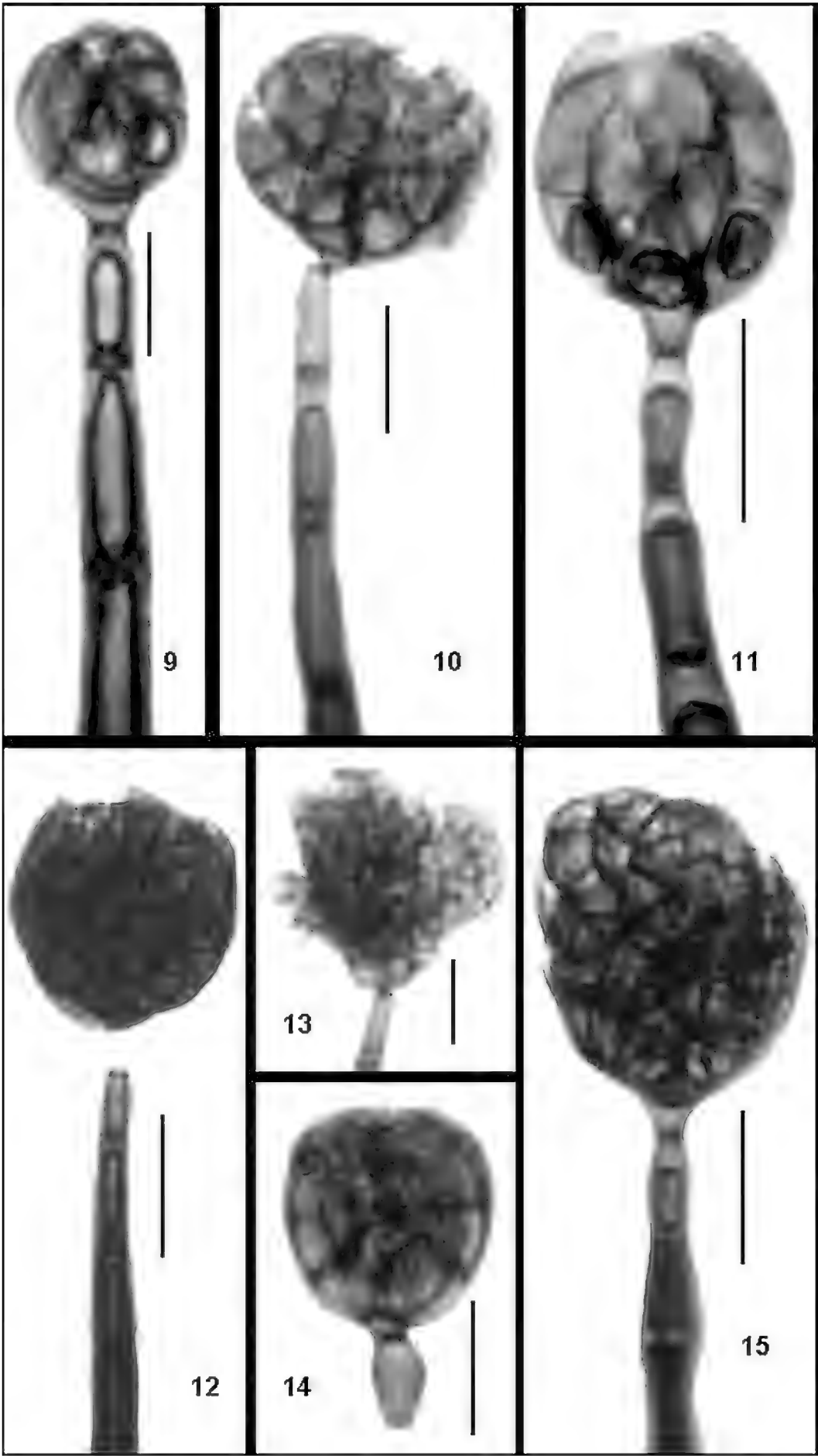
COLONIAE in substrato naturali effusae, pilosae, nigrae, brunneae. CONIDIOPHORA macronemata, mononemata, 4–7-septata, simplicia, $180\text{--}270 \times 12\text{--}15 \mu\text{m}$, atrobrunnea vel nigra ad usque basim versus brunnea ad apicem, laevia cum 2–6 proliferationibus enteroblasticis percurrentibus praedita. CELLULAE CONIDIOGENAE hologenosae, monoblasticae, cylindricae vel doliiformes, $15\text{--}37 \times 5\text{--}10 \mu\text{m}$, integratae, indeterminatae, atrobrunneae et brunneae ad apicem. SECESSIO CONIDIORUM schizolytica. CONIDIA solitaria, acrogena, dictyoseptata, sub-involuta ad usque imbricata, globosa, nonnunquam leviter laxa ad apicem vel irregularia, nigra, $31\text{--}46 \times 30\text{--}46 \mu\text{m}$, sicca, cum cellulis basalibus cuneiformibus, $6\text{--}9 \mu\text{m}$ latis, brunneis. Teleomorphosis ignota.

TYPE: “Los Tuxlas”, Estación de Biología, Veracruz, Mexico, on a decaying twig submerged in a stream, 19.V.2002. coll. R. M. Arias and J.Y.C. Elizondo (Holotype: XAL CB745).

ETYMOLOGY: Latin, *aquatica* – refers to its growth in water.

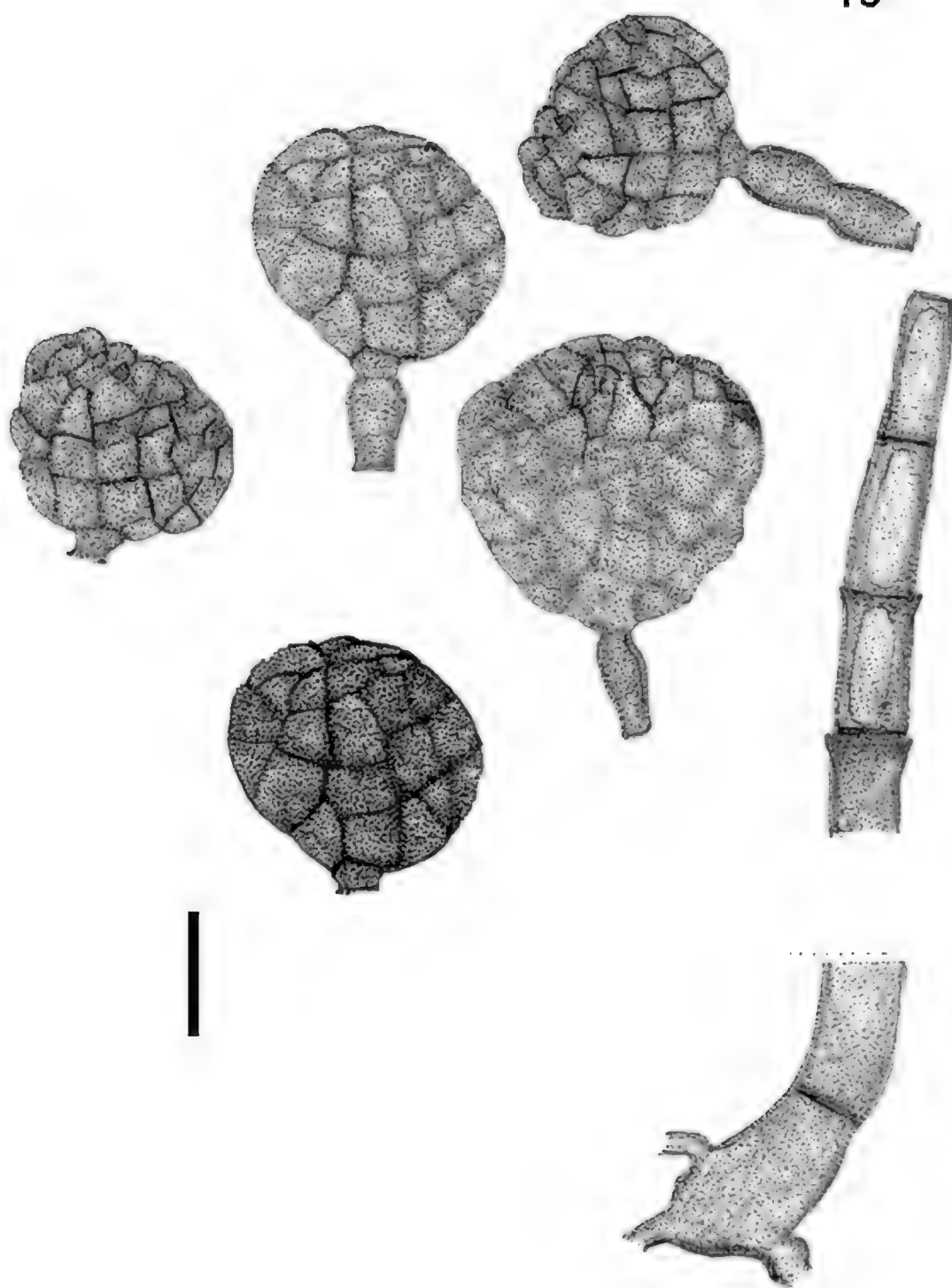
COLONIES on the natural substratum effuse hairy, black. MYCELIUM mostly immersed. Hyphae septate, branched, $2\text{--}3 \mu\text{m}$ diam, smooth-walled, black to dark brown. CONIDIOPHORES macronematous, mononematous, $180\text{--}270 \times 12\text{--}15 \mu\text{m}$, erect, straight or slightly curved, subulate, sometimes with a nodulose aspect after percurrent proliferation, 4–7-septate, single or sometimes loose fasciculate, dark brown or black at the base and brown towards the apex, smooth, with 2–6 enteroblastic percurrent proliferations. CONIDIOGENOUS CELLS holoblastic, monoblastic, terminal, cylindrical, doliiform to slightly subulate, integrated, indeterminate with enteroblastic percurrent proliferations, $15\text{--}37 \times 5\text{--}10 \mu\text{m}$, dark brown to brown, smooth-walled. CONIDIAL SECESSION schizolytic. CONIDIA solitary, acrogenous, dictyoseptate, globose, sub-involute, imbricate or irregular, sometimes slightly loose at the apex, $31\text{--}46 \times 30\text{--}46 \mu\text{m}$, black, dry with cuneiform, $6\text{--}9 \mu\text{m}$ wide, brown basal cells. Teleomorph unknown.

COMMENTS. The genus *Pseudoacrodictys* was introduced by Baker & Morgan-Jones (2003) to classify seven species previously described under a broad generic concept of *Acrodictys*; the included species were distinguished by more commonly indeterminate, enteroblastic percurrently proliferating, cylindrical, doliiform to subulate conidiogenous cells and schizolytic conidial secession. Conidia are holoblastic, solitary, acrogenous, subglobose to broadly pyriform to turbinate or irregular, dictyoseptate, bearing one or several aseptate or septate, somewhat “hyphae-like”, straight, undulate, involute to uncinuate cellular appendages. Subsequently another species was described, *Pseudoacrodictys dimorphospora* Somrith. & E.B.G. Jones (Somrithipol & Jones 2003), which strongly resembles *Ceratosporella compacta* (Castañeda et al. 1996). Only *P. deightonii* (M.B. Ellis) W.A. Baker & Morgan-Jones and *P. dennisii* (M.B. Ellis) W.A. Baker & Morgan-Jones (Baker & Morgan-Jones 2003) superficially resemble *P. aquatica*. *Pseudoacrodictys deightonii*, however, has conidia that



FIGS 9–15. *Pseudoacrodictys aquatica*, photographs from holotype (XAL CB 745). Conidiogenous cells and conidia. Scale is indicated by bars = 20 μm.

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FIGS 16. *Pseudoacrodictys aquatica*, drawings from holotype (XAL CB 745).
Conidiogenous cells and conidia. Scale is indicated by bars = 20 μm .

are highly variable in shape, ranging from irregularly turbinate to obpyriform with a botryose aspect derived from swollen and protruding peripheral cells ($42\text{--}84 \times 28\text{--}57 \mu\text{m}$) and a cuneiform, $3.5\text{--}5.0 \mu\text{m}$ wide basal cell; *P. dennisii* has conidia that are obovoid to pyriform, often somewhat flattened apically and sometimes compressed sub-apically and laterally, $26\text{--}57 \times 19\text{--}30 \mu\text{m}$ and distinctly protuberant, with a cylindrical, $4\text{--}6 \mu\text{m}$ wide, darker basal cell. Both species can be easily separated from *P. aquatica*.

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Literature cited

- Baker WA, Morgan-Jones G. 2003. Notes on hyphomycetes XCL. *Pseudoacrodictys*, a novel genus for seven taxa formerly placed in *Acrodictys*. *Mycotaxon* 85: 371–391.
- Castañeda Ruiz RF. 2005. Metodología en el estudio de los hongos anamorfos. In: Anais do V Congresso Latino Americano de Micología. Brasília, p. 182–183.
- Castañeda Ruiz RF, Kendrick B. 1991. Ninety-nine conidial fungi from Cuba and three from Canada. *University of Waterloo Biology series* 35: 1–132.
- Castañeda Ruiz RF, Guarro J, Cano J. 1996. Notes on conidial fungi. X. A new species of *Ceratosporella* and some new combinations. *Mycotaxon* 60: 275–281.
- Castañeda Ruiz RF, Guerrero B, Adamo GM, Morillo O, Minter DW, Stadler M, Gené J, Guarro J. 2009. A new species of *Selenosporella* and two microfungi recorded from cloud forest in Mérida, Venezuela. *Mycotaxon* 109: 63–74.
- Somrithipol S, Jones EBG. 2003. *Pseudoacrodictys dimorphospora* sp. nov., a new graminicolous hyphomycete from Thailand. *Sydowia* 55: 365–371.

***Endogenospora*, a new genus of anamorphic fungi from Venezuela**

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Abstract — *Endogenospora aspectabilis* anam. gen. et sp. nov. found on a decaying branch in the “Las Veras” rainforest, Lara State, Venezuela, is described and illustrated. It is characterized by endogenous conidium ontogeny development at the reduced internal area of inflated or globose bases of conidiophores, vase-shaped conidiogenous cells and clavate to sub-cylindrical, (5–)7-septate, brown conidia with truncate base and rounded apex.

Key words — tropical rainforest, systematics, conidial fungi

Introduction

During a survey of microfungi in Lara state, Venezuela, an interesting and curious anamorphic fungus was collected on decaying branches of an unidentified plant. Its conidium ontogeny and conidiogenous event development in the inner and deep-seated conidiogenous cell showed some resemblance with the genus *Conioscypha* Höhn., but also is superficially similar to the genus *Ascoconidium* Seaver by the urceolate to elongated infundibuliform conidiogenous cells. Therefore, the new genus *Endogenospora* is described and illustrated herein.

Materials and methods

Samples of plant material were collected during an expedition in July 2009 through the forest “Las Veras,” Lara State, Venezuela. Individual collections were placed in paper bags and taken to the laboratory, then incubated in Petri dishes at 25° C placed in a moist chamber composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of $\times 1000$. Micrographs were obtained with a Zeiss Axioskop 40 microscope.

Taxonomy

Endogenospora R.F. Castañeda, O. Morillo & Minter, **anam. gen. nov.**

MYCOBANK MB 515396

COLONIAE in substrato naturali effusae, brunneae ad usque nigrae. *CONIDIOPHORA* plerumque nulla, in cellula conidiogena reducta, interdum septata. *CELLULAE CONIDIOGENAE* endogenosae-holoblasticae, uniloculares, urceolatae, clavatae, subcylindricae vel prolongatae infundibuliformes, brunneae vel atrobrunneae, determinatae vel indeterminatae cum aliquot proliferationibus enteroblasticis percurrentibus, cum parietibus incrassatis, circa basim dispositae. *Loci conidiogeni* intra-suprabasilibus. *SECESSIO CONIDIORUM* schizolytica. *CONIDIA* solitaria, clavata usque ad cylindrica, manifeste enterogenice producentia, pluriseptata, brunnea vel atrobrunnea, laevia vel verruculosa, sicca vel tenuitunicata, seriata, in massa sicca, congesta. *Teleomorphosis* ignota.

SPECIES TYPICA: *Endogenospora aspectabilis* R.F. Castañeda, O. Morillo & Minter

ETYMOLOGY: Greek, *Endogeno-*, meaning endogenous, arising from inner and deep-seated layers of the conidiogenous cells; Latin *-spora* referring to the conidia.

COLONIES on the natural substrate effuse, brown or black. **CONIDIOPHORES** mostly absent, reduced to conidiogenous cells, sometimes septate. **CONIDIOGENOUS CELLS** endogenous-holoblastic, unilocal, vase-shaped, clavate, subcylindrical or elongated infundibuliform, brown or dark, determinate or with several enteroblastic percurrent proliferations, thick-walled, internal and deep, located



FIGS. 1–3. *Endogenospora aspectabilis*, photomicrographs from holotype (INIFAT C09/74). Conidiogenous cells and conidia. Enterogenous internal development of conidia near the base. Scale is indicated by bars = 10 μ m.

at the inflated base. CONIDIAL SECESSION schizolytic. CONIDIA solitary, clavate to cylindrical, enteroblastic, multi-septate, smooth or verrucose, dry or slightly tunicate, brown to dark brown, seriate, accumulating in dry masses.

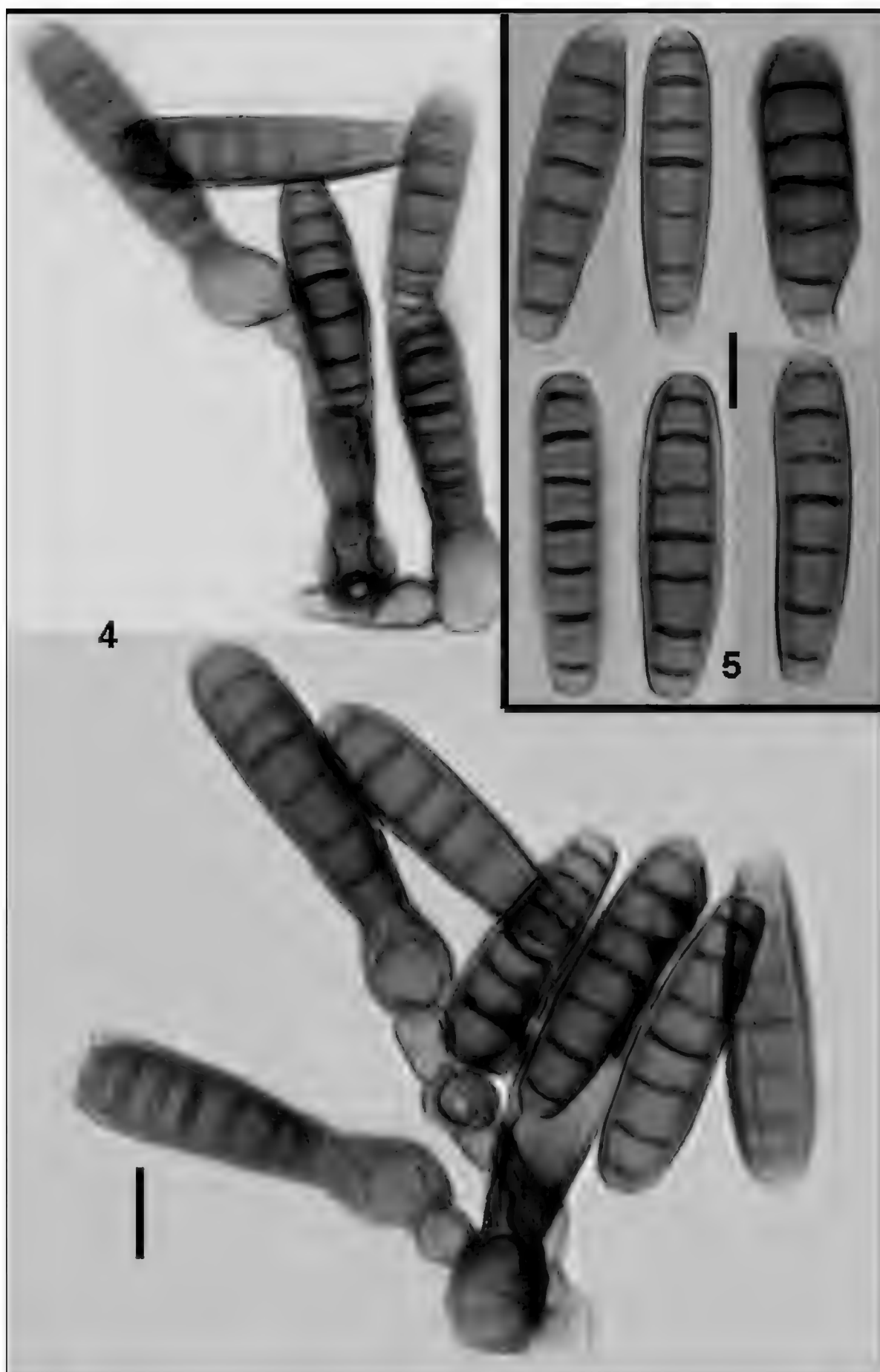
NOTES. The genus *Ascoconidium* can be compared with *Endogenospora* in conidium ontogeny, the shape and number of cells, but conidia are hyaline and sometimes dictyoseptate in the former; in both genera conidia are formed singly and successively after schizolytic secession, but conidia in *Ascoconidium* bear a conspicuous marginal frill produced by the separation process of the outer wall layer(s) and inner wall layer(s). The separation of the wall layers is not simultaneous, the outer wall layer(s) breaks first and conidia are observed attached only by the inner wall layer(s) as occurs in several anamorphic genera including *Stigmina* (Sutton & Pascoe 1989). The enterogenous conidium ontogeny occurs in an internal locus near the base, a process that shows obvious differences between *Ascoconidium*, *Endogenospora* and other genera such as *Chalara*, *Sporoschisma* and *Sporoschimopsis* as was discussed by Nag Raj & Kendrick (1975). Although the conidiogenous cells of these fungi have been described as “phialides”, the events relating to conidiogenesis are different, and the broadly applied term phialide does not accurately describe these stationary conidiogenous cells, which produce successive enteroblastic conidia. In *Endogenospora aspectabilis* inner wall layer(s) near the inflated base produce successive conidia in a process similar to what Minter et al. (1982) interpreted as holoblastic in *Cryptosporiopsis* sp. Minter et al. (1982) defined holoblastic as “the mode of production of cell wall in which, following completion of any developmental stage, the fungus in a new stage lays down wall layers which are continuous with all of the wall layers used in the previous stage.” This definition supports the description of conidiogenous cells in *Endogenospora aspectabilis* as endogenous-holoblastic because all inner wall layers are involved in the production of successive conidia and are continuous with the conidia wall layer. The vase-shaped conidiophores can be described as unicellular conidiomata when at maturation they produce successive conidia. *Endosporoideus* W.H. Ho et al. (2005) is also superficially similar to *Endogenospora*, but the former does not produce successive conidia, and after maturation shows disarticulation of the conidial cell similar to the “chlamydospora” of *Chalara* spp.

***Endogenospora aspectabilis* R.F. Castañeda, O. Morillo & Minter, sp. nov.**

MYCOBANK MB 515397

FIGS 1–6

COLONIAE in substrato naturali effusae, atrobrunneae vel brunneae. Mycelium plerumque superficiale vel in substrato immersum, ex hyphis septatis, cylindricis, aliquando cum cellulis globosis vel inflatis, (2.5–)4–6 μm diam., ramosis, dilute brunneis ad usque brunneis. CONIDIOPHORA plerumque nulla in cellula conidiogena reducta vel mononemata,



FIGS. 4–5. *Endogenospora aspectabilis*, photomicrographs from holotype (INIFAT C09/74).
4. Conidiogenous cells and conidia. 5. Conidia.
Scale is indicated by bars = 10 μ m.

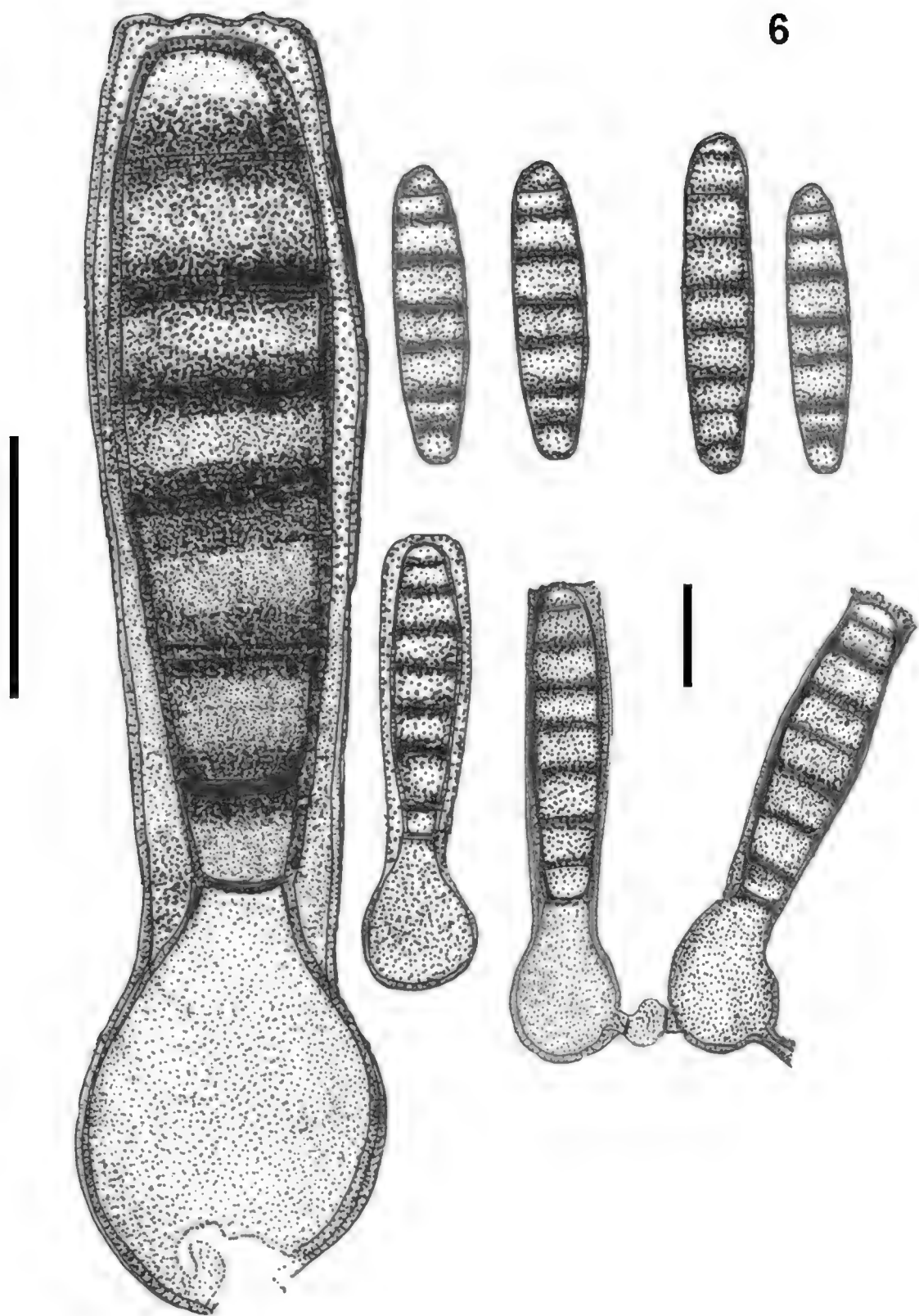


FIG. 6. *Endogenospora aspectabilis*, drawing from holotype (INIFAT C09/74).
Conidiogenous cells and conidia..
Scale is indicated by bar = 10 μ m.

fasciculata, 1-septata, laevia, brunnea, urceolata, vel prolongata, infundibuliformia, plerumque inflata vel globosa ad basim, 42–53 × 8–13 µm. CELLULAE CONIDIOGENAE urceolatae, clavatae, subcylindricae vel prolongatae infundibuliformes, ad basim globosae, enterogenosae, uniloculares, discretiae, brunneae vel atrobrunneae, plerumque determinatae, interdum indeterminatae cum 1–2 proliferationibus enteroblasticis percurrentibus, 7–11 × 8–13 µm, cum parietibus incrassantibus, brunneis, circa basim dispositae. Locis conidiogenis intra-suprabasilibus, complanatis. SECESSIO CONIDIORUM schizolytica. CONIDIA solitaria, endogenica, clavata usque ad cylindrica, sub-truncata ad basim, rotundata ad apicem, (5–)7-septata, brunnea vel atrobrunnea, sed utrimque pallidiora, i.e. pallide brunnea, 32–38 × 8.5–10.5 µm, laevia vel tenuitunicata, seriata, in massa atrobrunnea, sicca congesta. Teleomorphosis ignota.

TYPE: Las Veras, Barquismeto, Lara, Venezuela, on decaying branch of an unidentified plant, 25.VI.2009. O. Morillo (Holotype: INIFAT C09/74).

ETYMOLOGY: Latin, *aspectabilis* – meaning visible, worthy of being seen.

COLONIES on the natural substrate effuse, dark brown or brown. Mycelium mostly superficial and somewhat immersed; hyphae septate, branched, cylindrical and sometimes with globose to inflated, thickened cells, (2.5–)4–6 µm diam., smooth-walled, pale brown to brown. CONIDIOPHORES mostly absent, reduced to conidiogenous cells, but sometimes macronematous, mononematous, fasciculate, erect, straight, 1-septate, vase-shaped to elongated infundibuliform, always inflated or globose at the base, smooth-walled, 42–53 × 8–13 µm, brown or dark brown at the base, pale brown towards the apex. CONIDIOGENOUS CELLS unilocal, endogenous, enterogenous, globose, vase-shaped, clavate to slightly infundibuliform, discrete, determinate or indeterminate with 1–2 enteroblastic percurrent proliferations, 7–11 × 8–13 µm, with thickened, brown wall, smooth, arranged at the base near the bottom of the conidiomata. CONIDIOGENOUS LOCI internal and supra-basal, flattened. CONIDIA solitary, endogenously produced, clavate to sub-cylindrical, truncate at the base, rounded at the apex, (5–)7-septate, darkened at the septa, brown to dark brown and pale brown at the ends, 32–38 × 8.5–10.5 µm, smooth-walled or slightly tunicate, successively produced and accumulating in dark brown and dry masses. Teleomorph unknown.

Acknowledgements

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Literature cited

- Ho WH, Yanna, Hyde KD, Goh TK. 2005. *Endosporoideus* gen. nov., a mitosporic fungus on *Phoenix hanceana*. Mycologia 97: 238–245.
- Minter DW, Kirk PM, Sutton BC. 1982. Holoblastic phialides. Transactions of the British Mycological Society 79: 75–93.
- Nag Raj TR, Kendrick WB. 1975. A monograph of *Chalara* and allied genera. Waterloo: Wilfrid Laurier University Press.
- Sutton BC, Pascoe IG. 1989. Reassessment of *Peltosoma*, *Stigmina* and *Batcheloromyces* and description of *Hyphothyrium* gen. nov. Mycological Research 91: 210–222.

The genus *Leucocoprinus* in western Washington

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Abstract — The genus *Leucocoprinus* in Washington state was investigated based on fresh and herbarium collections as a part of a survey to assess the biodiversity and abundance of all lepiotaceous (*Agaricaceae*) fungi in the Pacific Northwest. Seven species were found to occur in the study area. *Leucocoprinus* (*Lc.*) *flavescens* is reported from Washington while *Lc. brebissonii* and *Lc. heinemannii* are credibly recorded in North America for the first time. The complex history of *Lc. cretaceus* in North America including its first record from Washington is discussed. The above four species as well as *Lc. birnbaumii*, *Lc. cepistipes*, and *Lc. ianthinus* are described and their microscopic characters illustrated.

Keywords — agarics, introduced species, western North America

Introduction

Pale-spored members of the family *Agaricaceae* (lepiotaceous fungi as defined by Vellinga 2004a; formerly *Lepiotaceae*) have remained rather understudied in North America (Vellinga, 2004a). The western half of the continent has received little attention since the works of Burlingham (1945), Murrill (1912), and Zeller (1922, 1929, 1933 1934, 1938). The methods of investigation ignored characters now considered of great importance, and microscopic features were left essentially unexamined. Although the lepiotaceous flora of California (and to a lesser extent that of Oregon) has received much attention in the last 40 years bringing to light many of the details needed to clarify species' identities and relationships (Smith & Sundberg 1979; Sundberg 1967, 1971a, 1971b, 1976, 1989 1995; Vellinga 2001a, 2001b, 2007a, 2007b, 2007c, 2007d; Vellinga & Davis 2007; Vellinga & Sundberg 2008), pacific northwest species have been relatively neglected, except for the work by Sieger (2003).

In an attempt to lessen the disparity of knowledge regarding lepiotaceous fungi, the present paper is presented as a first in a series of investigations concerned with assessing the biodiversity of lepiotaceous fungi in the Pacific Northwest.

The genus *Leucocoprinus* Pat. was originally erected to accommodate the sulcate/plicate species intermediate between *Leucoagaricus* (La.) Locq. ex Singer and *Macrolepiota* Singer (Singer 1986). This position is problematic as there are many *Leucoagaricus* species that have moderately to slightly sulcate pileus margins. The distinction was clarified with the discovery of pseudoparaphyses (also called brachybasidioles and pavement cells) between the basidia, which species of *Leucoagaricus* lack.

Genetic investigations have not well supported *Leucocoprinus* as independent but show its species intermixed with *Leucoagaricus* species. The possible monophyly of *Leucocoprinus* cannot, however, be completely rejected (Vellinga 2004b). The present paper treats *Leucocoprinus* as an artificial but conveniently recognizable morpho-genus rather than a natural assemblage of species. It appears that the presence of pseudoparaphyses is not phylogenetically significant, but it is still unclear whether this character has evolved several times to give rise to close groups of species or whether it has been gained and lost several times at the species level and thus has no particular taxonomic value. Here *Leucocoprinus* is used in a sense that excludes species of *Leucoagaricus* section *Annulati* and section *Piloselli* — e.g., *La. americanus* (Peck) Vellinga, *La. badhamii* (Berk. & Broome) Singer — which some authors (e.g. Moser 1967; Reid 1990) have included.

Species of *Leucocoprinus* appear to benefit greatly from human disturbance. They grow quickly and readily in potting soils and other man-made organic-rich materials in which they appear to have been transported. As a result, it is probable that all seven species known to occur in Washington were introduced during the 20th century. *Leucocoprinus brebissonii* is especially interesting: since the first report in 1994, its populations have become very common and are now readily encountered in most Puget Sound basin forests. Vellinga (2001c) suggests that *L. brebissonii* has become more common in the Netherlands due to increasing nitrogen enrichment of the soil (Vellinga 2001c).

The first report of a *Leucocoprinus* species from Washington was “*Lepiota cretacea* (Bull.) Morgan” reported by Murrill (1912), who cited “*Lepiota cepaestipes* Quél.” as a synonym. It is impossible to discern exactly what species Murrill reported as he had an extremely broad species concept (see remarks under *Lc. cretaceus*). Sheridan (1956) reported *Lc. birnbaumii* (as “*Lepiota lutea* (Bolton) Matt.”) from Washington for the first time as a common greenhouse inhabitant or found outdoors in soil that had been artificially heated during the winter. The next two additions to the Washington *Leucocoprinus* mycota were *Lc. cepistipes* and *Lc. ianthinus* (as *Lc. “lilacinogranulosus”*) by Sieger (2003). This paper presents the first reports of *Lc. flavescens* and *Lc. cretaceus* (in the narrow sense) from Washington state and the first documented reports of *Lc. brebissonii* and *Lc. heinemannii* from North America.

Materials and methods

Synonyms are listed only when helpful or informative. For a complete list, see Vellinga (2009). The generic names *Lepiota*, *Leucoagaricus*, and *Leucocoprinus* are abbreviated as *L.*, *La.*, and *Lc.*

Because of the lack of data on fresh material, the macroscopic description for *Lc. ianthinus* is borrowed from Sieger (2003). Color notations in quotation marks are from Ridgway (1912).

Descriptions of microscopic characters were made using the glossary of Vellinga & Noordeloos (2001) whenever possible. Microscopic observations were made from exsiccate revived in 3% KOH. Dimensions were recorded from 30 measurements made from one specimen for spores (in profile view), cheilocystidia, and pileus covering cells. Ten basidia and pseudoparaphyses from each collection were measured. Measurements and Q-values (a ratio of length over width) are displayed as follows: lower extreme–mean–upper extreme. Pseudoparaphyses, sterigmata, and basidia were measured during, or shortly after, sporulation. The pileus covering was sectioned at the disc and mid-margin and near the edge to observe the full variability of pileus structure. When possible, both immature and mature pileus were sectioned to determine the development of the covering.

All cited collections are deposited at the University of Washington herbarium (WTU).

Results

Of the seven species of *Leucocoprinus* encountered, four were found to grow only indoors or in artificially heated habitats, one grew both indoors and outdoors, and two were found only outdoors. Basidiocarps of *Leucocoprinus* species are most often encountered July through September rarely fruiting as late as November.

The seven *Leucocoprinus* species known from Washington state are described and illustrated. An artificial key to their identification is presented below.

Key to *Leucocoprinus* species of Washington

- 1. Carpophores with yellow tones 2
- 1. Carpophores lacking yellow tones 3
- 2. Center of pileus with fulvous tones, lacking scales; pileus covering composed of loosely arranged globose cells; spores subglobose, lacking a germ pore 5. *Leucocoprinus flavescens*
- 2. Center of pileus lacking fulvous tones, with distinct scales; pileus covering lacking globose cells; spores broadly amygdaliform and with a distinct germ pore 1. *Leucocoprinus birnbaumii*
- 3. Pileus and stipe covered with a copious farinose covering; lacking contrasting scales or fibrils; entire fruiting body white to cream colored 4. *Leucocoprinus cretaceus*
- 3. Pileus and stipe only slightly farinose (if at all); with contrasting scales or fibrils. . . . 4

- 4. Pileus with black to dark grey disc and scales 5
- 4. Pileus with purple to brown colored disc and scales 6
- 5. Pileus with minute, granule-like scales; found in forests (suspected from green-houses) 2. *Leucocoprinus brebissonii*
- 5. Pileus with small, fibrillose scales; known only from greenhouses 6. *Leucocoprinus heinemannii*
- 6. Pileus with small, violet- to lilac-brown scales; found indoors (to date) in flower pots etc. 7. *Leucocoprinus ianthinus*
- 6. Pileus with medium to small, brown to tan, appressed scales; found in wood-chips, compost heaps, gardens etc. 3. *Leucocoprinus cepistipes*

1. *Leucocoprinus birnbaumii* (Corda) Singer, Sydowia 15(1-6): 67 (1962) FIG. 1
 = *Agaricus birnbaumii* Corda, Icon. Fung. (Prague) 3: 48 (1839)
 = *Lepiota lutea* Godfrin, Bull. Soc. mycol. Fr. 13: 33 (1897)
 = *Leucocoprinus luteus* (Godfrin) Locq., Bull. mens. Soc. linn. Lyon 14: 93 (1945)

PILEUS: 2.0–7.5 cm, at first paraboloid to cylindrical, later paraboloid to obtusely conical upon expansion, more or less plane to broadly umbonate with age; margin at first incurved, later decurved, sometimes straight with age, sulcate-striate; with appressed-fibrillose scaly to squarrose scales; disc solid, breaking up outward into scales on a somewhat farinose background, these often absent by 3/4th out; scales “old gold” to “Verona brown” to “raw umber;” background “barium yellow” to “citron yellow” to “massicot yellow” to “naphthalene yellow” to “sulphur yellow”, pallid in the furrows; texture moderately firm when young but soft and fragile with age. ODOR: absent to sometimes fungal (like *Lycoperdon* spp.). LAMELLAE: free, often noticeably remote, subdistant to crowded, ventricose with age, soft, very thin, “sulphur yellow” to “citron yellow”, edge notably fimbriate. STIPE: 2.5–9.0 cm long, 2–6 mm broad at apex, often gradually enlarging below to a slightly enlarged to somewhat clavate to bulbous, 4–15 mm broad, base, farinose to pruinose to somewhat floccose-squamulose, “citron yellow” to “massicot yellow” to “naphthalene yellow,” sometimes discoloring “buffy brown”, hollow and stuffed with pith. ANNULUS: thin, felt-like, superior to inferior, moveable, band-like, “citron yellow” to “barium yellow” to “naphthalene yellow;” rarely leaving remnants on pileus margin.

SPORES: 7.7–8.9–10.5 × 5.9–6.5–7.3 μm, Q-value 1.12–1.36–1.56, ellipsoid to slightly amygdaliform in profile view, thick-walled, with a large apical germ pore that is often covered with a hyaline cap, metachromatic, dextrinoid. BASIDIA: 19.8–27.5 × 7.7–11.0 μm, pyriform to narrowly clavate, 4-spored, surrounded by four pseudoparaphyses. STERIGMATA: 1.4–2.2 × 0.8–1.2 μm. PSEUDOPARAPHYSES: 16.5–22.1 × 10.5–12.8 μm, narrowly utriform to narrowly clavate, lacking a pedicel, often somewhat angular. CHEILOCYSTIDIA:

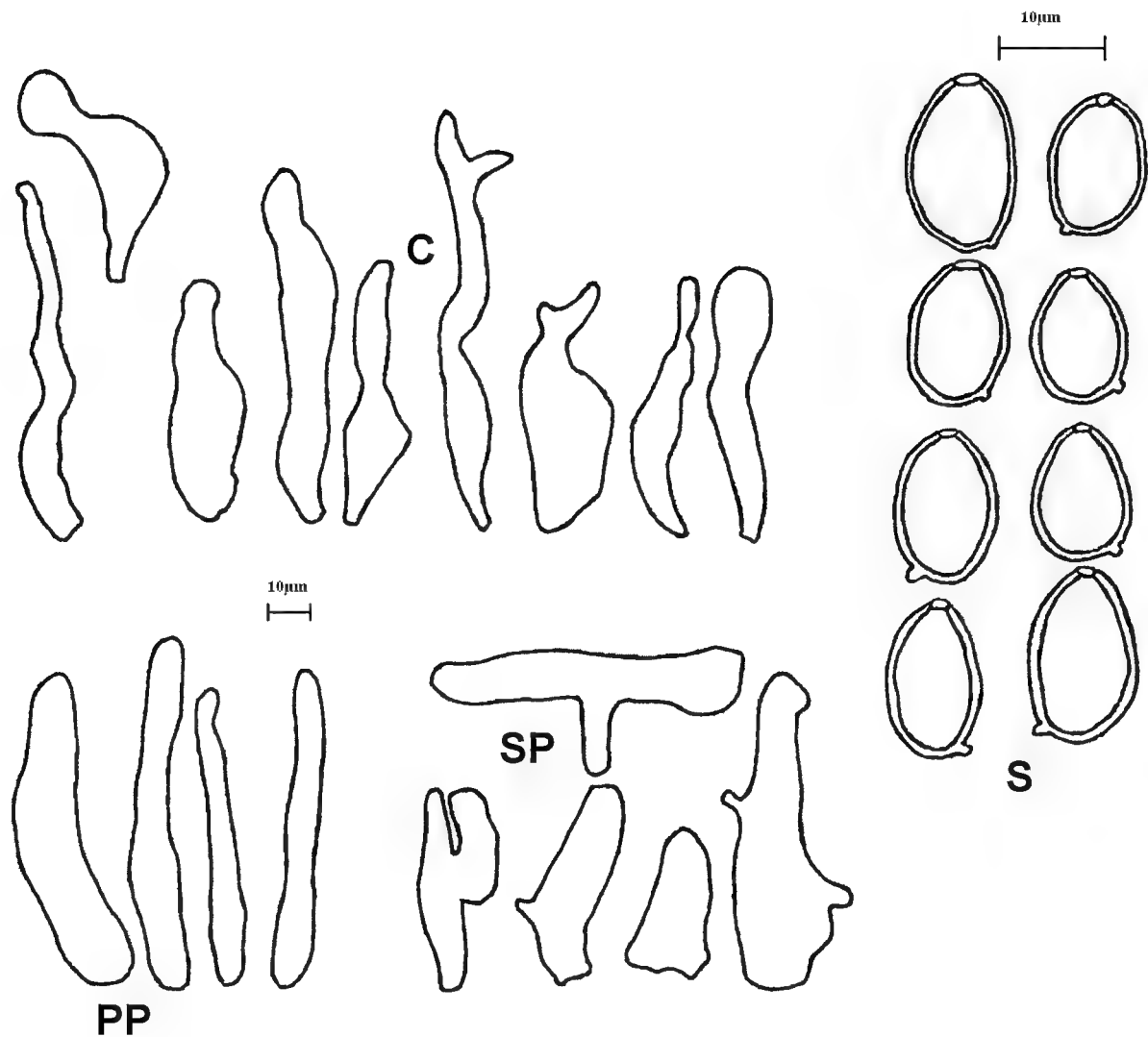


FIGURE 1. *Leucocoprinus birnbaumii* –
S. spores; C. cheilocystidia; PP. pileus covering; SP. contextual elements
(all from collection PBM 1943).

22.5–40.4–62.5 × 7.5–11.3–14.3 µm, very variable, lageniform to fusiform, less often clavate to utriform, at apex often with a flexuous excrescence that is up to ½ of total length, rarely with mucronate to obtuse apices, thin-walled, often with somewhat yellow colored vacuolar contents. PILEUS COVERING: a confluent layer of terminal cells when young, disarticulating into scales and/or patches revealing short, inflated to cylindrical, loosely attached cylindrical, H-, T- to L-shaped contextual elements (these being the only discernable cell type in poorly preserved collections or in collections in which scales are indistinct or absent). Terminal elements ascending to somewhat repent conglomerations of 32.5–65.7–155.0 × 7.5–12.8–18.8 µm, flexuous cylindrical to somewhat narrowly lageniform to rarely elongate clavate terminal. STIPE COVERING: composed of repent to ascending, cylindrical, 5–8 µm broad elements similar to the terminal elements of the pileus. STIPITIPPELLIS: a cutis made up of 10–15 µm broad, cylindrical elements. CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: solitary to subconnate imbricate in rich soils, very often in greenhouses or in flowerpots indoors. Cosmopolitan.

COLLECTIONS EXAMINED: U.S.A.: Washington, King Co., Seattle: PBM 1943, det. P.B. Matheny, 8/21/2000; University of Washington Botany greenhouse: SAR 88/417, det. S.A. Rehner, 2/24/1988; University of Washington campus: MTS 4997, det. M.T. Seidl, 8/29/2002; STZ 9330, det. D. Stuntz, 11/09/1955. Spokane Co., Whitworth College: D. Brown 9/1989, det. J.M. Birkebak

REMARKS: The bright yellow coloration and cosmopolitan distribution in areas of human disturbance has made *Lc. birnbaumii* one of the most easily recognized mushrooms. Its toxicity (Singer 1986) further contributes to its fame.

The species is reputedly an indoor species in northern temperate locations, but it has been collected outdoors in Washington in an area with artificially heated soils (Sheridan 1956). It is unclear whether this species is truly restricted to artificially warm soils, as I have heard many unconfirmed reports and at one point seen what appeared to be an immature *Lc. birnbaumii* in natural conditions in a pacific northwest forest.

There is some confusion regarding the structure of the pileus covering, and sometimes only the upper contextual elements are described and illustrated (e.g., Sundberg 1967, Pegler 1972).

2. *Leucocoprinus brebissonii* (Godey) Locq., Bull. mens. Soc. linn. Lyon

12: 41. 1943

FIG. 2

=*Lepiota brebissonii* Godey in Gillet, Hyménomycètes: 64. 1874.

PILEUS: 2.0–5.5 cm broad, short cylindrical when very young, becoming conic to convex to more or less paraboloid, sometimes becoming plano-convex when mature, often collapsing to more or less truncate conic; margin often straight to decurved, sulcate-striate, sometimes with sparse velar remnants, often eroding with age; disc subtomentose to velutinous, immediately around disc breaking up into granular scales that are very sparse near margin; “dark grey” to black to sometimes “fuscous” tinted, rarely as pale as “smoky grey;” context white, rarely discoloring slightly yellow, very soft and thin, somewhat fragile. **ODOR:** distinctly fungal. **LAMELLAE:** free, close to crowded, 2–6 mm broad, at margin fimbriate; white or with “cream buff” tints. **STIPE:** 3.5–9.0 cm long, 1–4 mm thick at apex, enlarging downward to clavate, 3–6(–10) mm thick base, sometimes rather flexuous, central to very rarely slightly eccentric, often appearing minutely fibrillose or minutely pruinose near apex, white to “ivory yellow,” sometimes discoloring pinkish flesh-colored to dingy orange-pink with age especially near the base, at very base often with some light grey tints, hollow and often stuffed, somewhat fibrous–friable when fresh. **ANNULUS:** thin, upturned, median; white to pale cream, sometimes leaving loose remnants on the pileus margin.

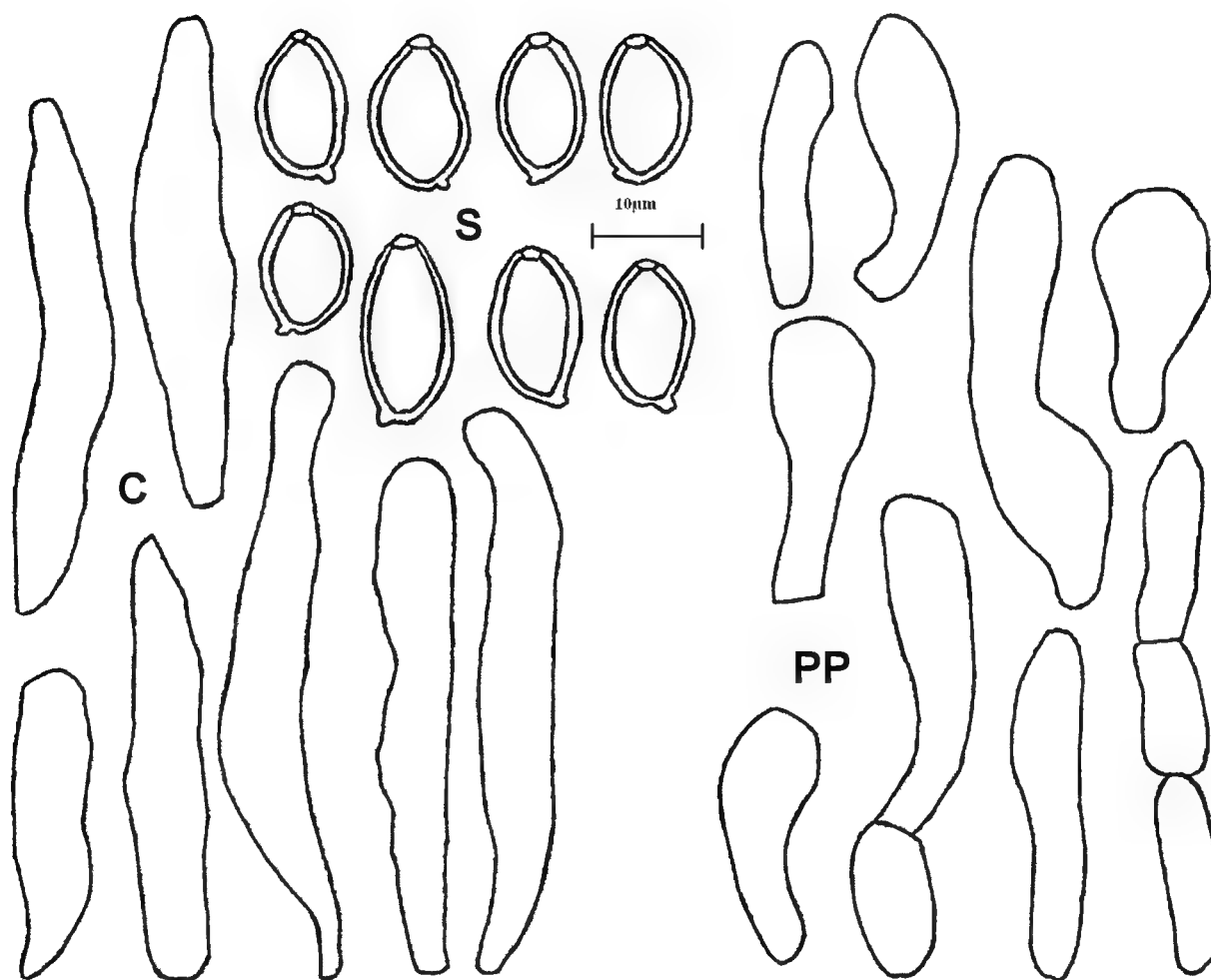


FIGURE 2. *Leucocoprinus brebissonii* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection JMB 9-13-2006-01).

SPORES: $9.2\text{--}10.6\text{--}12.1 \times 4.9\text{--}6.0\text{--}7.2 \mu\text{m}$, Q-value $1.50\text{--}1.77\text{--}2.08$, oblong ellipsoid to slightly amygdaliform, thick-walled, with an apical germ pore that often somewhat slants toward the adaxial side, metachromatic, dextrinoid. BASIDIA: $18.7\text{--}23.1 \times 9.2\text{--}10.8 \mu\text{m}$, pyriform, 4-spored, surrounded by four pseudoparaphyses. STERIGMATA: $1.0\text{--}1.5 \times <0.7 \mu\text{m}$. PSEUDOPARAPHYSES: $14.3\text{--}17.6 \times 6.6\text{--}10.2 \mu\text{m}$, narrowly clavate, only slightly enlarged at apex. CHEILOCYSTIDIA: $22.0\text{--}46.8\text{--}73.7 \times 7.7\text{--}11.4\text{--}19.8 \mu\text{m}$, cylindrical to very slightly fusiform, somewhat flexuous, often slightly constricted before the apex giving the cells a slightly capitate appearance, often somewhat pedicellate to tapered, thin-walled, hyaline. PILEUS COVERING: a dense layer of terminal cells that disarticulates into several minute scales and remaining confluent at disc revealing cylindrical to sometimes branching, repent, contextual elements; terminal cells $26.3\text{--}41.8\text{--}60.0 \times 15.0\text{--}19.1\text{--}27.5 \mu\text{m}$, broadly clavate to ellipsoid to pyriform, often with a very broad point of attachment, rarely with a short pedicel, filled with grayish-olive brown vacuolar pigment, somewhat loosely chained with 1–6 pigmented elements that become narrower, longer and blend

into contextual cells. STIPE COVERING: restricted to very base, composed of cylindrical to sometimes narrowly clavate, moderately pigmented, sparse elements. STIPITIPPELLIS: a cutis made up of 7.5–11.3 μm broad, cylindrical, repent elements. CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: scattered to gregarious, sometimes imbricate and more or less connate, growing on duff of *Alnus rubra*, *Acer macrophyllum* and/or *Thuja plicata*, less commonly on debris of *Tsuga heterophylla* and/or *Pseudotsuga menziesii* or sometimes on very decayed *Thuja plicata* wood. Known from throughout the tropics: known from Europe and the Pacific Northwest (where it is likely invasive for the latter; see below) in temperate areas.

COLLECTIONS EXAMINED: U.S.A.: Washington, King Co., Bridle Trails State Park: LB 2007-06-18-05, LB 2007-06-21-06, LB 2007-07-16-09, LB 2007-07-23-01, LB 2007-07-23-02, LB 2007-07-27-03, LB 2007-07-30-01, All det. J.M. Birkebak and L. Bayler; Carkeek Park: JMB 68, det. J.M. Birkebak, 10/13/2003; D. Oliver s. n. 2004, det. J.M. Birkebak, 2004; Coal Creek Park: JMB 75, det. J.M. Birkebak, 9/25/2003; Fauntleroy Park, JMB 258, det. J.M. Birkebak, 9/17/2004; JMB 9-13-2006-01, det. J.M. Birkebak, 9/13/2006; Lincoln Park: JMB 56, det. J.M. Birkebak, 9/30/2003; Redmond Preserve: Forrest Beckwith 7140402, det. J.M. Birkebak, 7/14/2004; St. Edwards State Park: GRW 778, det. J.M. Birkebak, 10/02/1994. Snohomish Co., Tulalip: M. Bennett 6/24/2004, det. J.M. Birkebak.

REMARKS: *Leucocoprinus brebissonii* may be the most commonly encountered *Leucocoprinus* species in Washington. This species has probably gone unnoticed, despite its abundance, as a misdetermined *Lepiota atrodisca* Zeller, another species that features black scales on a white background but which is easily distinguished by a more robust stature and the vastly differing microscopic characters easily distinguish it. *Leucocoprinus heinemannii*, the other *Leucocoprinus* species with a black pileus covering, is differentiated by its punctate scales and short, broad elements.

Leucocoprinus brebissonii appears to have been introduced to Washington, as its first collection dates from 1994; given its current abundance, it is highly improbable that it could have gone uncollected and unnoticed for so long. This species has become naturalized to a great extent and is commonly encountered in most forests in the greater Seattle area. Whereas interspecies competition and displacement are poorly known, it is impossible to determine whether the arrival of this species has impacted native mycoflora to any significant extent.

This report extends the known distribution of *Lc. brebissonii* to include North America. The three previous reports of this species from North American are doubtful or ambiguous. Smith's (1981) report of "*Lc. brebissonii*" refers to a fibrillose pileus composed of narrow, somewhat cylindrical elements, features that clearly separate her description from the current concept and likely represent something in the *Lepiota atrodisca* complex (Else Vellinga, pers.

com.). Arora (1986) mentioned collecting “*Lepiota*” *brebissonii* from a lawn in Berkeley, California. Not only is this habitat highly unusual, the description of the carpophores as “2-3cm, with brownish to grayish scales,” casts further doubt upon his identification, as *Lc. brebissonii* is described as a black to dark grey (at palest) species; the name is probably a misapplication based on Smith’s 1981 species concept. It has not been seen in the Berkeley area since this report (Else Vellinga, pers. com.) and there is also no preserved collection that can be examined. Akers (1997) reports “*Leucocoprinus cf. brebissonii*” from Florida, but the reference seems doubtful as he described the stature as resembling *Lc. fragilissimus* “(Rav. & Berk.) Pat.,” a much more fragile species than *Lc. brebissonii*.

The present paper cites many collections for the species in Washington, and the nrITS sequence of Washington material is identical to those from European collections (Else Vellinga, pers. com.). The distribution in North America needs further investigation.

3. *Leucocoprinus cepistipes* (Sowerby: Fr.) Pat., J. Bot., Paris 3: 336 (1889)

[sensu J. E. Lange]

FIG. 3

≡ *Lepiota cepistipes* (Sowerby: Fr.) P. Kumm., Führ. Pilzk. : 136 (1871)

PILEUS: 2.5–5.5 cm broad, ovoid to conic when young, becoming obtusely campanulate, broadly umbonate to somewhat truncate at times; margin at first incurved, becoming straight to more often decurved, sulcate-striate; glabrous to finely appressed tomentose at disc, toward margin becoming diffracted into sometimes slightly recurved to appressed squamulae, widely spaced near margin, rest of surface radially fibrillose to farinose; disc and scales “mummy brown” to “hazel” to “sayal brown” to “snuff brown” to “cinnamon brown” to “cinnamon” to “clay color” to “buffy brown” to “warm buff” to “honey yellow,” background white to “pale pinkish buff” to “pale cream buff;” context soft (but rather sturdy for this genus), more or less white. ODOR: mild, fungal. LAMELLAE: free, often noticeably remotely so, close, rather broad, thin; white, sometimes discoloring “amber yellow,” edge notably fimbriate. STIPE: 2.5–7.5 cm long, 1.5–4.0 mm broad at apex, often slightly and gradually increasing in breadth downward to an often moderately clavate base, 6–7 mm broad base, glabrous to innately fibrillose to slightly tomentose (especially toward base), “light vinaceous cinnamon” to “light pinkish cinnamon” to “pinkish buff” to “buffy brown” to “avellaneous,” generally darker downward, often discoloring “clay color” to “sayal brown.” ANNULUS: membranaceous, flaring, superior, “avellaneous” to “buffy brown” to “cinnamon.”

SPORES: 7.7–9.2–10.5 × 5.5–6.7–7.7 μm, Q-value 1.19–1.37–1.52, ellipsoid to slightly amygdaliform, thick-walled, with an apical germ pore covered with a hyaline lens, metachromatic, dextrinoid. BASIDIA: 22.9–28.3 × 9.7–10.8 μm,

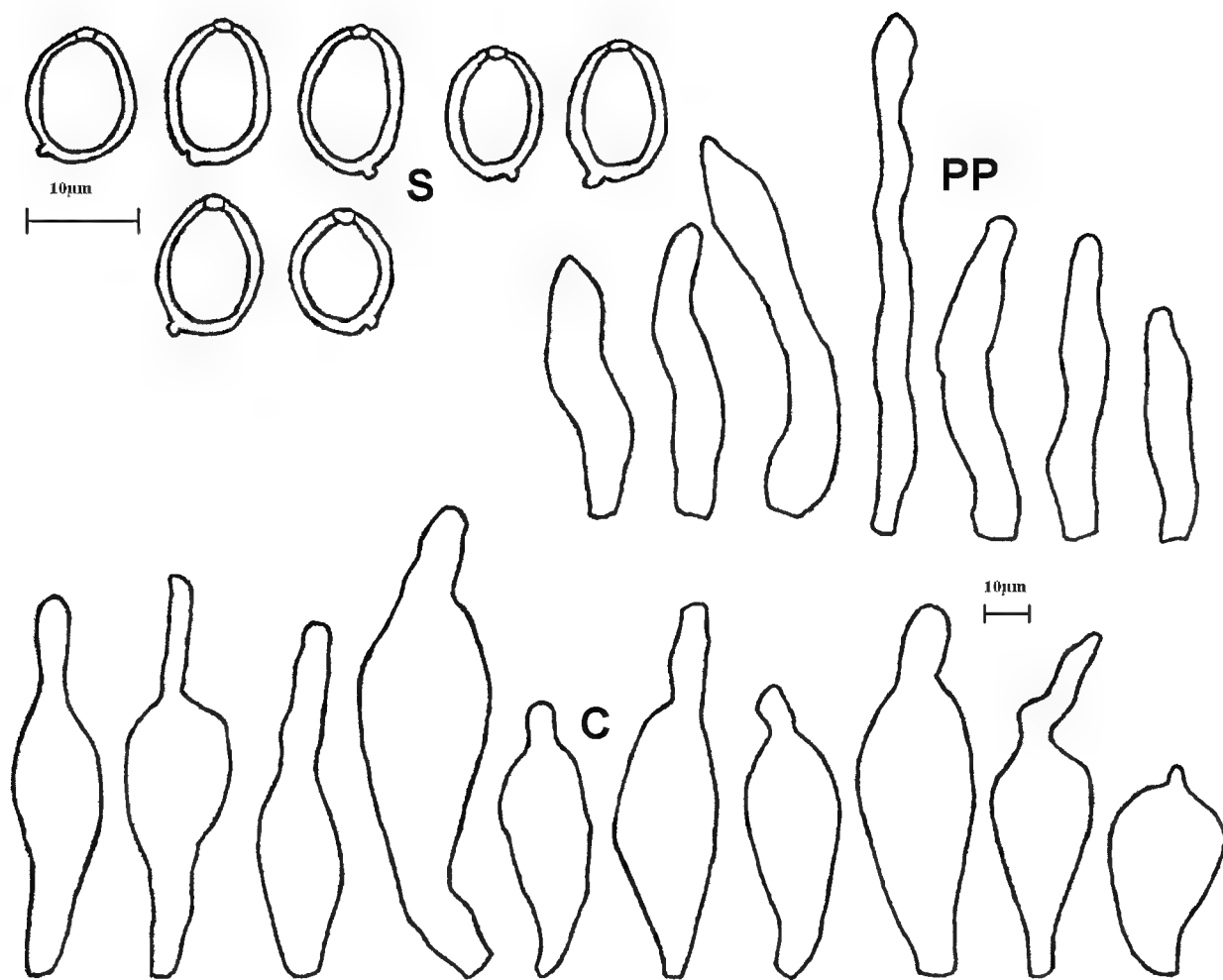


FIGURE 3. *Leucocoprinus cepistipes* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection STZ 14210).

clavate pedicellate to cylindrical pedicellate, 4- to rarely 2-spored, surrounded by 4 pseudoparaphyses. STERIGMATA: $1.4\text{--}2.2 \times 0.7\text{--}1.2\ \mu\text{m}$. PSEUDOPARAPHYSES: $16.4\text{--}18.7 \times 9.4\text{--}10.4\ \mu\text{m}$, pyriform to more or less sphaeropedunculate with a very short, broad pedicel, rarely broadly fusiform. CHEILOCYSTIDIA: $30.0\text{--}45.3\text{--}57.5 \times 10.0\text{--}14.8\text{--}17.5\ \mu\text{m}$, clavate to lageniform to rarely fusiform, often with a pedicel of short to moderate length, with obtuse to mucronate apices or with a flexuous, often tapering but sometimes capitulate, rarely forked, $4.5\text{--}6.5\ \mu\text{m}$ broad excrescence up to $2/5^{\text{th}}$ of cystidium length, thin-walled, hyaline. PILEUS COVERING: a loose turf of terminal cells when young, thinning with age and breaking into scales, revealing repent, cylindrical to T-shaped contextual elements that often become loose and disarticulated; terminal cells $32.5\text{--}56.0\text{--}92.5 \times 5.6\text{--}8.3\text{--}11.3\ \mu\text{m}$, very variable, flexuous, lageniform to less often cylindrical to narrowly clavate, yellowish brown, loosely chained; with 2-5 pigmented, angular globose to short cylindrical cells that generally blend into trama. STIPE COVERING: like pileus covering but more often cylindrical to narrowly clavate, less often lageniform, shorter and broader, $30.4\text{--}58.0 \times 7.6\text{--}10.8\ \mu\text{m}$. STIPITPELLIS: made up of cylindrical, $10.0\text{--}17.5\ \mu\text{m}$ broad, elements.

CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: solitary to gregarious to subconnate imbricate on rich soils, compost heaps, and wood chips. Can be found both indoors (greenhouse) and outdoors. Cosmopolitan.

COLLECTIONS EXAMINED: U.S.A.: Washington, King Co., Foster Island: STZ 14859, det. D. Stuntz, 9/12/1968; Lincoln Park: STZ 14210, det. D. Stuntz, 8/30/1967; University of Washington Arboretum: STZ 18980, det. J.M. Birkebak, 9/8/191975; University of Washington Botany Greenhouse: FVDB 3787, det. F. Van De Bogart, 9/23/1976; STZ 786, det. J.M. Birkebak, 9/10/1944; STZ 1638, det. D. Stuntz, 8/9/1945; STZ 19453, det. J.M. Birkebak, 9/10/1976.

REMARKS: This cosmopolitan *Leucocoprinus* rivals *Lc. brebissonii* as the most common representative of the genus in Washington. Like many of its brethren, this species fruits both indoors and outdoors.

One *Lc. cepistipes* collection included numerous primordia in a large, tight, confluent patch with mature specimens. The development of the universal veil and the hymenophoral cavity was found to be essentially the same as described for *Lepiota clypeolaria* (Bull. : Fr.) P. Kumm. and *Lepiota magnispora* Murrill (Atkinson 1914). The only difference noticed was that considerable elongation of the stipe tissue (2–3 mm) preceded hymenophoral differentiation and enlargement of the pileal cells. This difference between cell enlargement in the stipe and lack of enlargement in the center of the pileus context explains the abrupt cellular difference between the pileus and stipe context causing their very easy separation (“ball and socket” attachment).

4. *Leucocoprinus cretaceus* (Bull.: Fr.) Locq., Bull. mens. Soc. linn. Lyon

14: 93 (1945)

FIG. 4

=*Lepiota cretacea* (Bull.: Fr.) Morgan, J. Mycol. 13: 3 (1907)

=*Lepiota farinosa* Peck, Rep. N.Y. St. Mus. nat. Hist. 43: 81. (1890)

=*Leucocoprinus breviramis* H.V. Sm. & N.S. Weber, Contrib. Univ. Mich. Herb. 15: 301. (1982)

PILEUS: 3.5–6.0 cm broad, hemispherical when young, expanding to plano-convex to campanulate, often somewhat umbonate; margin decurved, slightly sulcate-striate, at most sulcate to 1/5th to center; when young with many, dense, soft floccules, readily collapsing or wearing off to leave farinose covering; “light buff” to white at center, white elsewhere. LAMELLAE: remotely free, close, rather broad, thin; white, edge slightly fimbriate. STIPE: 5–8 cm long, 4–6 mm broad at apex, gradually enlarged downward to a broadly clavate to somewhat fusiform 6–13 mm broad base; sometimes coarsely farinose to slightly flocculose-farinose below annulus, subfarinose above; white to ivory yellow tinted (especially darker below). ANNULUS: very soft, somewhat flaring, median to superior, white.

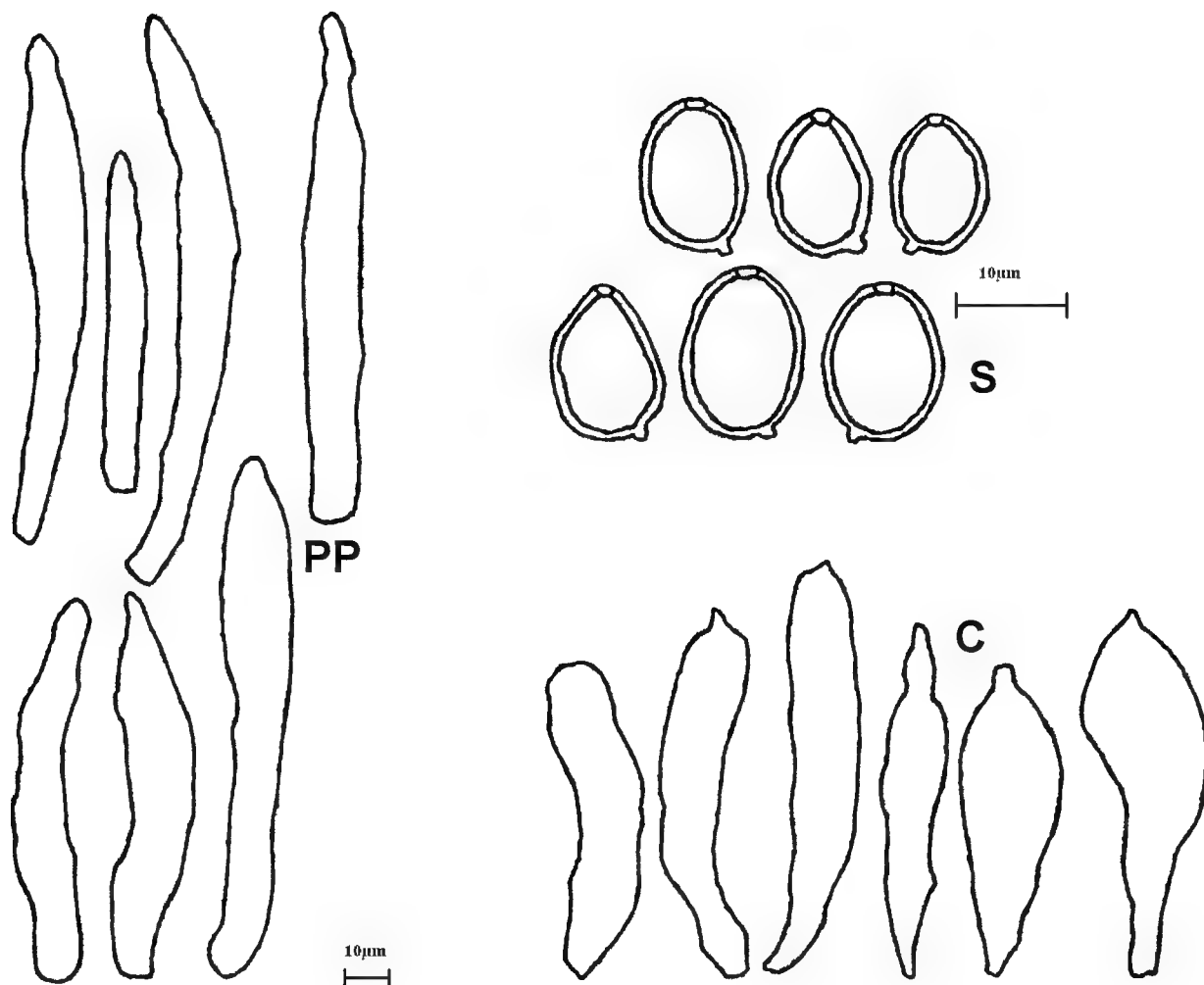


FIGURE 4. *Leucocoprinus cretaceus* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection SJ22).

SPORES: $8.1\text{--}9.4\text{--}11.8 \times 5.9\text{--}6.8\text{--}7.8 \mu\text{m}$, Q-value 1.32–1.47, ellipsoid to somewhat amygdaliform, thick-walled, with an apical germ pore covered with a hyaline lens, metachromatic, dextrinoid. **BASIDIA:** $16.9\text{--}21.3 \times 9.3\text{--}11.2 \mu\text{m}$, pyriform to somewhat clavate with a somewhat bulbous base, 4-spored, surrounded by 4 pseudoparaphyses. **STERIGMATA:** $1.3\text{--}2.0 \times 0.7\text{--}1.1 \mu\text{m}$. **PSEUDOPARAPHYSES:** $10.4\text{--}13.3 \times 7.4\text{--}9.6 \mu\text{m}$, sphaeropedunculate to broadly clavate to pyriform, point of attachment very broad. **CHEILOCYSTIDIA:** $27.0\text{--}49.3\text{--}75.6 \times 7.2\text{--}10.5\text{--}17.6 \mu\text{m}$, subcylindrical to narrowly fusiform to slightly narrowly lageniform, mucronate, rarely obtuse, or with a flexuous excrescence, moderately pedicellate, thin-walled, hyaline. **PILEUS COVERING:** a sparse layer of terminal cells essentially absent on mature pilei, most prevalent near the center of young pilei, $45.0\text{--}73.9\text{--}117.0 \times 7.0\text{--}8.1\text{--}9.3 \mu\text{m}$, cylindrical to somewhat narrowly lageniform, with flexuous necks, often mucronate or with a short, tapering, apical excrescence with thinner wall than subterminal cells, very loosely chained to elements that become shorter, broader and blending with the anastomosing, often H- to T-shaped very loosely disarticulating contextual elements with numerous excrescences: these elements being very common on

the entirety of the pileus surface and making up the farinose covering. STIPE COVERING: structure like that of pileus, with terminal cells even more sparse. STIPITIPPELLIS: a cutis of narrowly cylindrical, 5.0–7.5 μm broad elements. CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: subconnate imbricate on heap of mixed wood chips and horse manure. Cosmopolitan.

COLLECTION EXAMINED: USA: Washington, Snohomish Co., Monroe: SJ 22, det. J.M. Birkebak, 9/28/1990.

REMARKS: My species concept for *Lc. cretaceus* follows Bulliard's original (for a detailed account of the complex history of usage of the name *Agaricus cretaceus* see Vellinga 2001c).

In North America most authors — notably Morgan (1907) and Kauffman (1924) — have applied the name *Lepiota cretacea* to what is now considered *Leucocoprinus cepistipes* (i. e. sensu J. E. Lange). Murrill (1914), however, used the name *Lepiota cretacea* in its broadest sense, which included *Leucocoprinus birnbaumii* (as “*Agaricus luteus* With.”), *Leucocoprinus cepistipes* (as “*Lepiota cepaestipes* Quél.”), and even *Leucocoprinus fragilissimus* (as “*Hiatula fragilissima* Berk. & Rav.”).

Peck (1890) created the name *Lepiota farinosa* for the all white, farinose species here referred to *Lc. cretaceus*. Murrill (1911, 1914) included Peck's species as a synonym for *L. cretacea*. To complicate matters further, Smith and Weber (1982), who applied the name *Lc. cretaceus* to the current concept of *Lc. cepistipes*, published the name *Lc. breviramus* for the species I refer to *Lc. cretaceus*. Their “*breviramus*” is distinguished only by slightly smaller spores and subtle differences in the size and shape of cheilocystidia, differences that I regard as taxonomically insignificant. Akers (1997) applies the name *Lc. breviramus* to what clearly represents my concept of *Lc. cretaceus*.

5. *Leucocoprinus flavescens* (Morgan) H.V. Sm., The Michigan Botanist

20(2): 50 (1981)

FIG. 5

=*Lepiota flavescens* Morgan, Journal of Mycology 13(1): 5 (1907)

PILEUS: 20–32 mm broad when expanded, cylindrical with a blunt disc in button stage, rounded conic to more obtuse and with a rounded umbo, more or less collapsing and curling on drying; margin decurved to straight, sulcate-striate, especially so in older specimens; surface dry and coated with a more or less loose granular layer; at disc “barium yellow” to “amber yellow” or faintly tinted brown, “sulphur yellow” to white tinted with “sulphur yellow” to “naphthalene yellow” outward, paler at margin; context very thin and soft, pliable, white with yellow tint at cuticle on disc. Odor: more or less pungent. LAMELLAE: free, more or less close, narrow; edges straight at first then becoming crisped with age; faces white, edge appears tinted with more or less “sulphur yellow” to “pale yellowish

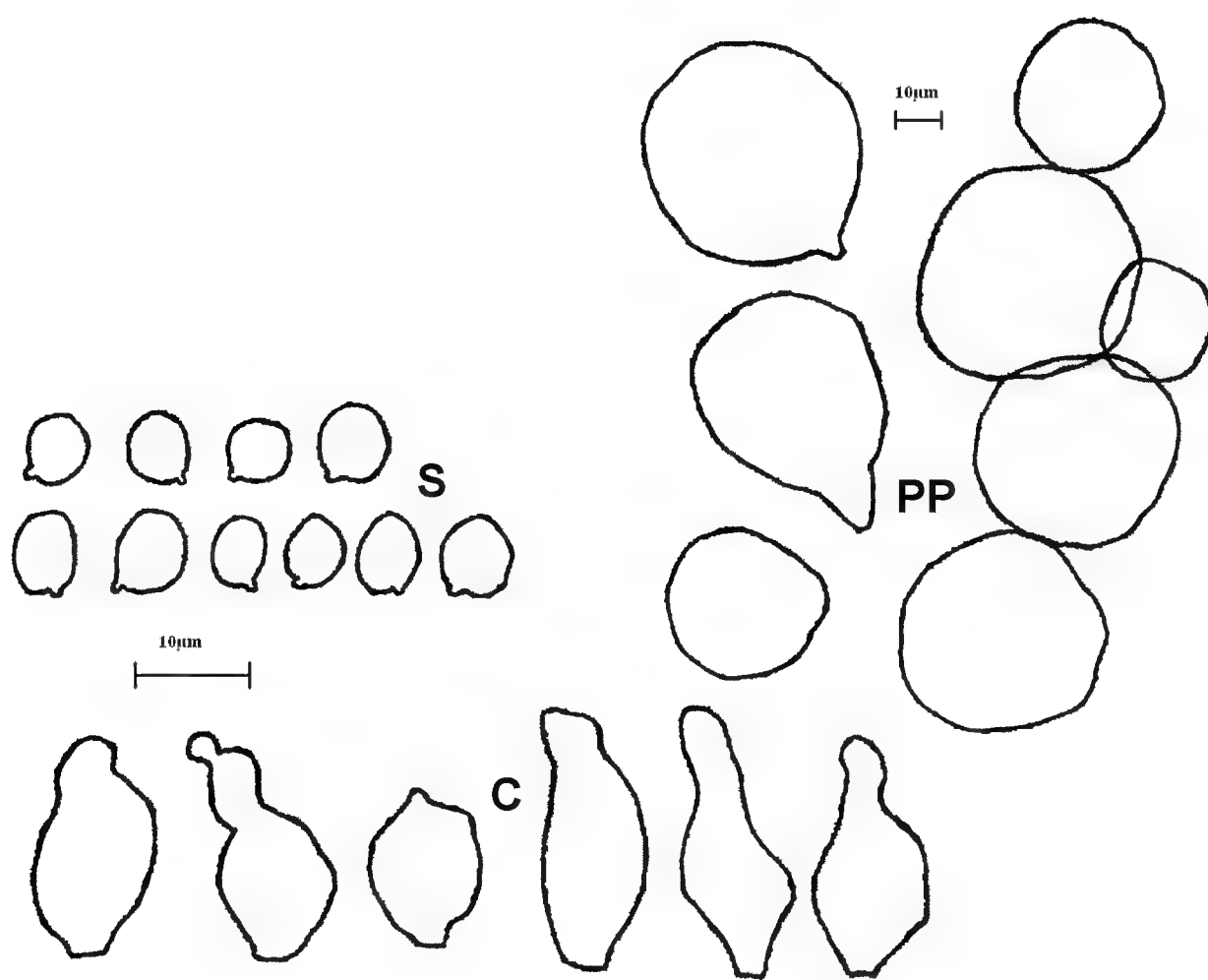


FIGURE 5. *Leucocoprinus flavescentis* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection JFA 8466).

white.” STIPE: 65–85 mm long, at apex 4mm wide, at base narrowly clavate (up to 5–6 mm); with a granular to farinose coating; more or less “sulphur yellow” or this tinted with white, in age and with handling the stipe becomes deeper and brighter yellow (more or less “picric yellow”). ANNULUS: fragile, moveable, median to superior, “sulphur yellow” to “picric yellow.”

SPORES: $4.4\text{--}5.1\text{--}5.9 \times 3.6\text{--}4.1\text{--}4.8 \mu\text{m}$, Q-value 1.00–1.27–1.42, broadly ellipsoid, thin walled, dextrinoid, metachromatic. BASIDIA: $13.4\text{--}16.5 \times 6.1\text{--}7.2 \mu\text{m}$, clavate pedicellate to pyriform, 4-spored; surrounded with 4 pseudoparaphyses at right angles (in a more or less checkerboard pattern). STERIGMATA: $1.7\text{--}2.2 \times 0.7\text{--}1.0 \mu\text{m}$. PSEUDOPARAPHYSES: $11.4\text{--}15.3 \times 6.9\text{--}8.5 \mu\text{m}$, sphaeropedunculate to broadly clavate, more rarely ellipsoid with very short pedicel, often somewhat angular/isodiametric. CHEILOCYSTIDIA: $11.0\text{--}17.1\text{--}24.2 \times 5.5\text{--}8.2\text{--}13.2 \mu\text{m}$, very variable, lageniform to utriform to, more rarely, clavate to obclavate, apex obtuse to mucronate or with a strangulate to constricted-subcapitate excrescence up to $\frac{1}{2}$ of cell length, thin walled, hyaline.

PILEUS COVERING: of a loose layer of terminal elements concentrated on disc and somewhat sparse on rest of pileus, on a cutis of cylindrical, repent contextual elements; terminal elements loose globose to subglobose, sometimes ellipsoid, $13.8\text{--}34.4\text{--}50.0 \times 15.0\text{--}30.3\text{--}47.5\text{ }\mu\text{m}$, (Q-value 1.00–1.14–1.32) loosely chained, sometimes with a short excrescence connecting it to adjacent cells, generally more ellipsoid to fusiform downward. **STIPE COVERING:** composed of loose, globose elements like those of the pileus covering. **STIPITIPPELLIS:** composed of short, cylindrical elements 20–30 μm broad. **CLAMP CONNECTIONS:** absent.

HABITAT AND DISTRIBUTION: In an outdoor covered can filled with greenhouse potting soil, growing in large clusters at ambient temperature. For distribution see remarks below.

COLLECTION EXAMINED: USA: Washington, King Co., Seattle, University of Washington campus: JFA 8466, det. J.M. Birkebak, 12/19/1979.

REMARKS: This sole representative of section *Denudati* Beeli in Washington has been collected only once in the Pacific Northwest. It was found on the University of Washington campus in a covered can outside of the botany greenhouse.

This is the first report of *Leucocoprinus flavescentis* in the Pacific Northwest. It was originally described from Ohio (Morgan 1907) and also from Illinois (Kuo 2007), Massachusetts, and California (the last two from greenhouses; Smith 1981).

6. *Leucocoprinus heinemannii* Migl., Micol. Ital. 16(2): 9 (1987)

FIG. 6

PILEUS: 16–22 mm when expanded, ovate when young, expanding to convex to plano-convex, center sometimes slightly depressed, often with a small umbo; margin more or less straight to uplifted, sulcate-striate; disc black to dark grey, innately fibrillose, very soon breaking into small, fibrillose scales on a white background that thin greatly until nearly absent near margin; context very thin and fragile, white. **ODOR:** fungal. **LAMELLAE:** free, crowded, somewhat broad, white. **STIPE** 12–35 mm long, 2 mm broad at apex, with an enlarged, bulbous, up to 5 mm broad base, with abundant white rhizomorphs from base, longitudinally silky, often innately fibrillose; white, often with a thin black to “dark grey” band near very base of stipe, hollow; context white. **ANNULUS:** membranous, white, somewhat band-like to slightly upturned, median.

SPORES: $6.3\text{--}6.9\text{--}7.4 \times 3.5\text{--}3.8\text{--}4.2\text{ }\mu\text{m}$, Q-value 1.66–2.10, oblong ellipsoid, rarely slightly amygdaliform or slightly phaseoliform, thin-walled, dextrinoid, faintly metachromatic. **BASIDIA:** $14.5\text{--}17.8 \times 7.3\text{--}8.4\text{ }\mu\text{m}$, broadly clavate, rarely pyriform, 4-spored; surrounded with 4 pseudoparaphyses at right angles (in a more or less checkerboard pattern). **STERIGMATA:** $1.5\text{--}2.2 \times 0.8\text{--}1.1\text{ }\mu\text{m}$. **PSEUDOPARAPHYSES:** $8.9\text{--}13.3 \times 4.4\text{--}6.8\text{ }\mu\text{m}$, broadly clavate to short cylindrical, more rarely ellipsoid, point of attachment often quite broad. **CHEILOCYSTIDIA:**

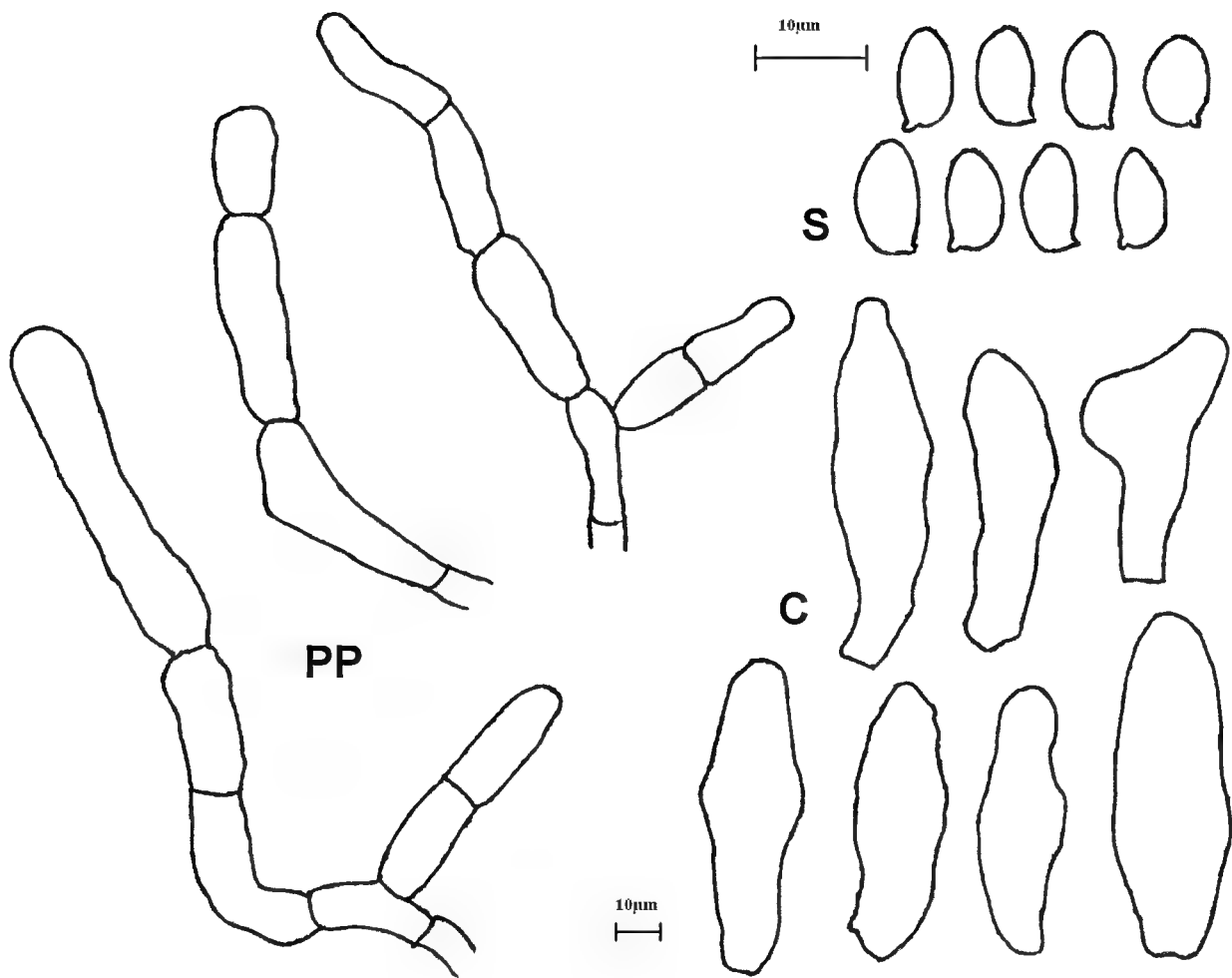


FIGURE 6. *Leucocoprinus heinemannii* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection JMB 07-11-08-2001).

15.1–20.1–25.9 × 5.2–7.2–8.9 µm, cylindrical, broadly fusiform to slightly utriform, occasionally somewhat irregular in outline, not distinctly pedicellate, thin-walled, hyaline. PILEUS COVERING: a loose cutis made of long chained, cylindrical to inflated, 23.4–42.6–63.0 × 6.1–8.6–14.4 µm, olivaceous grey to dark brownish grey vacuolar pigmented elements with moderately constricted septa, occasionally developing slight secondary septations, blending into cylindrical to branched, hyaline contextual elements. Bare areas a cutis of cylindrical to branching, hyaline hyphae. STIPE COVERING: limited to the very base of the stipe, like that of the pileus but elements thinner and less strongly pigmented. STIPITIPPELLIS: a cutis made of narrowly cylindrical to somewhat interwoven, 4–9 µm broad cells. CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: gregarious in potting soil in greenhouses. Known from Europe and western North America.

COLLECTIONS EXAMINED: U.S.A.: Washington, King Co., University of Washington Botany greenhouse: JMB 07-07-2008-01, det. J.M. Birkebak, 7/7/2008; JMB 07-11-2008-01, det. J.M. Birkebak, 7/11/2008; JMB 07-18-2008-01, det. J.M. Birkebak, 7/18/2008.

REMARKS: The pileus margin of this species is barely sulcate and strongly resembles *Leucoagaricus* species, especially *La. melanotrichus* (Malençon & Bertault) Trimbach (see Migliozi & Zecchin 1999). This species also resembles *L. phaeostictiformis* Murrill from Florida but this similarity needs closer examination.

This species has probably been found in the University of Colorado greenhouse (Vellinga, pers. com.).

7. *Leucocoprinus ianthinus* (Sacc.) Locq., Bull. mens. Soc. linn.

Lyon 14: 94. (1945)

FIG. 7

=*Lepiota ianthina* Sacc., Syll. Fung. 9: 10 (1891) [as "*Lepiota janthina*"]

=*Leucocoprinus lilacinogranulosus* (Henn.) Locq., Bull mens. Soc. linn. Lyon 12: 94 (1943)

=*Lepiota lilacinogranulosus* Henn., Verh. bot. Ver. Prov. Brandenb. 40: 145 (1898)

PILEUS: 1.5–4.5 cm broad, ovoid to parabolic when young, truncate conic and collapsing slightly with age; margin decurved when young, sulcate-striate; disc unbroken, violet brown to reddish violet, breaking into minute granular scales the color of the disc or lighter on a buff background. ODOR: unremarkable or merely fungal. LAMELLAE: free, crowded, becoming wrinkled, whitish aging to pale flesh. STIPE: 4–5 cm long, 2.5–4.0 mm thick at apex, base bulbous; whitish, darker at base, not changing when bruised. ANNULUS: membranous, whitish, median. (Adapted from Singer 2003)

SPORES: $8.8\text{--}9.9\text{--}11.6 \times 6.0\text{--}6.8\text{--}7.7 \mu\text{m}$, Q-value 1.29–1.46–1.60, ellipsoid to somewhat amygdaliform, sometimes tapering slightly toward apical germ pore, with a small hyaline cap, thick-walled, thinning toward apex, dextrinoid, metachromatic. BASIDIA: $18.7\text{--}25.1 \times 7.7\text{--}9.9 \mu\text{m}$, pyriform to clavate, less often cylindrical-pedicellate, 4-spored, surrounded by 4 pseudoparaphyses. STERIGMATA: $2.3\text{--}3.3 \times 1.1\text{--}1.7 \mu\text{m}$. PSEUDOPARAPHYSES: $16.6\text{--}20.5 \times 9.6\text{--}11.4 \mu\text{m}$, sphaeropedunculate to broadly clavate. CHEILOCYSTIDIA: $37.5\text{--}60.1\text{--}88.6 \times 11.3\text{--}17.3\text{--}23.8 \mu\text{m}$, quite variable, cylindrical to utriform to broadly clavate, often, but not always, distinctly pedicellate, thin walled, hyaline. PILEUS COVERING: of a dense covering of terminal elements that breaks into scales usually leaving the disc confluent, revealing cylindrical to branching, hyaline contextual elements; terminal elements more or less erect, loose chains of 2–4, lightly grayish-lilac vacuolar pigmented, globose to cylindrical, $12.5\text{--}20.4\text{--}28.8 \times 8.8\text{--}12.4\text{--}21.3 \mu\text{m}$. STIPE COVERING: restricted to very base of stipe, erect to semi-erect, cylindrical elements, approximately $50\text{--}75 \times 5\text{--}8 \mu\text{m}$. STIPITIPPELLIS: a cutis made of rather short, cylindrical, $13\text{--}18 \mu\text{m}$ broad elements. CLAMP CONNECTIONS: absent.

HABITAT AND DISTRIBUTION: solitary to gregarious on potting soil in artificially high temperatures indoors (especially prevalent in greenhouses). Cosmopolitan

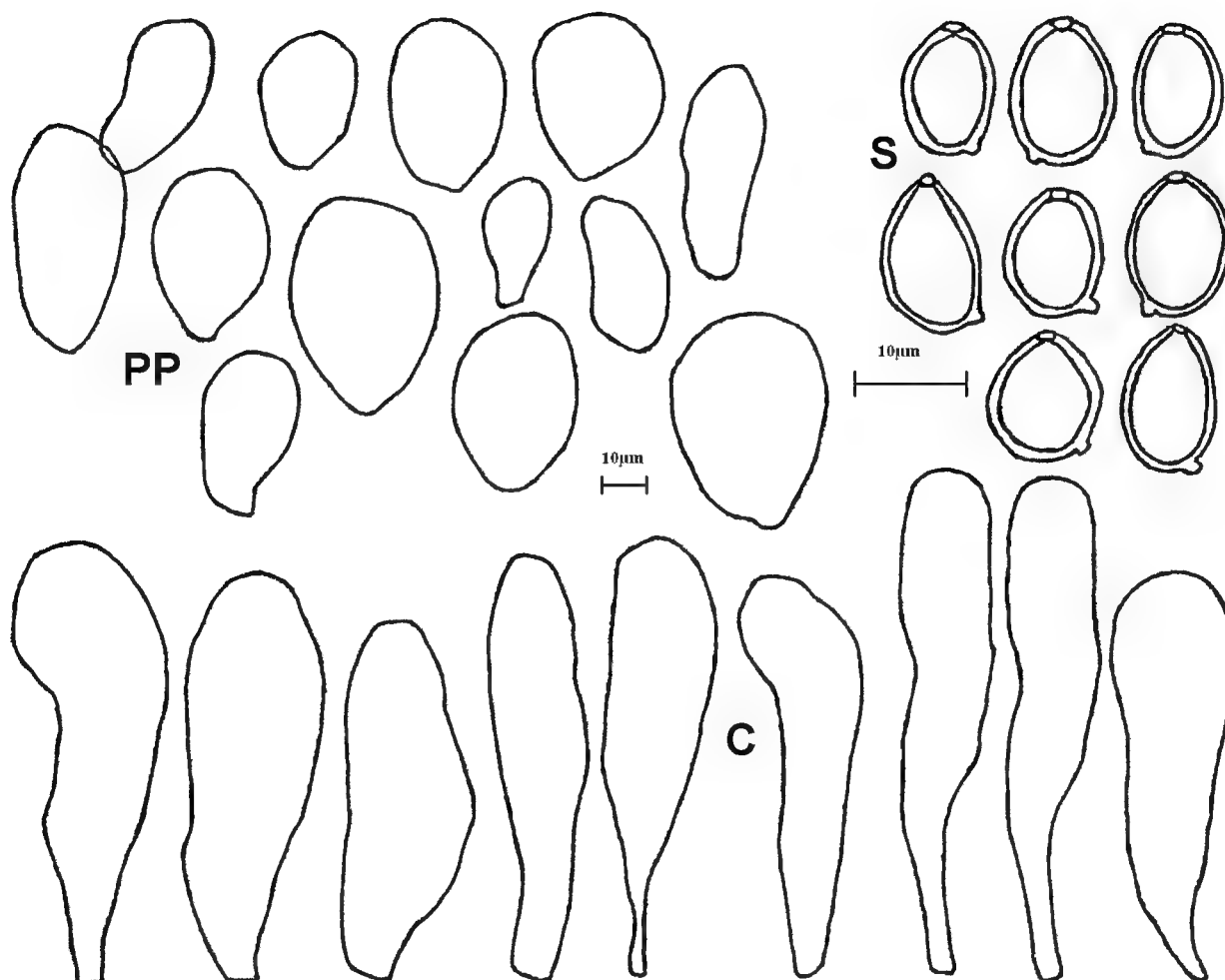


FIGURE 7. *Leucocoprinus ianthinus* – S. spores; C. cheilocystidia; PP. pileus covering (all from collection SAT 99-198-01).

COLLECTIONS EXAMINED: U.S.A.: Washington, King Co., Seattle: PBM 0020—040096, det. P. B. Matheny (as *Lepiota lilacinogranulosus*); SAT 99-198-01, det. S. Trudell (as “*Leucocoprinus lilacinosquamulosus*”), 7/17/1999; University of Washington Botany greenhouse: JFA 10097, det. J.M. Birkebak, 5/23/1990.

REMARKS: This distinctive species is the only *Leucocoprinus* with purple tones known from western North America. It has been collected several times in plant pots indoors. It has not yet been found outdoors.

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Literature cited

- Akers BP. 1997. The family *Lepiotaceae* (*Agaricales*, *Basidiomycetes*) in Florida. Thesis, Southern Illinois University, Carbondale, 253 p.
- Arora D. 1986. Mushrooms demystified. Ed.2. Ten Speed Press: Berkeley, CA. 959p.
- Atkinson GF. 1914. The development of *Lepiota clypeolaria*. *Annales mycologici* 12: 346–356.
- Burlingham GS. 1945. Noteworthy species of *Lepiota* and *Lactaria*. *Mycologia* 37: 53–64.
- Kauffman CH. 1924. The genus *Lepiota* in the United States. *Papers from the Michigan Academy of Science, Arts and Letters* 4: 319–344.
- Kuo M. 2007 (October). *Leucocoprinus flavescentis*. Retrieved from http://www.mushroomexpert.com/leucocoprinus_flavescentis.html (accessed 7/24/2008).
- Migliozi V, Zecchin G. '1998,' 1999. Comparaison entre *Leucocoprinus heinemannii* et *Leucoagaricus melanotrichus* (*Agaricales*, *Fungi*). *Belg. J. Bot.* 131: 169–175.
- Morgan AP. 1907. North American species of *Lepiota* (concluded). *Journal of Mycology* 13: 1–18.
- Moser MM. 1967. *Kleine Kryptogamenflora*, Edn 3 (Stuttgart) 2(b/2): 186.
- Murrill WA. 1911. The *Agaricaceae* of Tropical North America: II. *Mycologia* 3, (2): 79–91.
- Murrill WA. 1912. The *Agaricaceae* of the Pacific Coast-II. *Mycologia* 4, (5): 231–262.
- Murrill WA. 1914. *Lepiota*. *North American Flora* 10 (1): 41–65.
- Peck CH. 1890. Annual Report of the State Botanist over 1889. Rep. N.Y. St. Mus. nat. Hist. 43.
- Pegler DN. 1972. A revision of the genus *Lepiota* from Ceylon. *Kew Bull.* 27: 155–202.
- Reid DA. 1990. The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in ammonia fumes. *Mycol. Res.* 94: 641–670.
- Ridgway R. 1912. Color standards and color nomenclature. Washington, D.C., published privately. 43 pp + 53 color pls.
- Sheridan WL. 1956. Note on the ecology of *Lepiota lutea*. *Ecology* 37: 602–603.
- Sieger RE. 2003. Trial key to Pacific Northwest *Lepiota* and allies. Pacific Northwest Key Council [<http://www.svims.ca/council/Lepiota.htm>].
- Singer R. 1986. The *Agaricales* in modern taxonomy. 4th ed. Koeltz Scientific Books, Koenigstein, 982p.
- Smith HV. 1981. Some species of *Leucocoprinus* which grow in greenhouses. *Michigan Botanist* 20: 45–52.
- Smith HV, Sundberg WJ. 1979. Studies on the *Lepiotaceae* of the Pacific Coast Region. I. Two new species. *Mycotaxon* 8: 446–452.
- Smith HV, Weber NS. 1982. Selected species of *Leucocoprinus* from the southeastern United States. *Contributions from the University of Michigan Herbarium* 15: 297–309.
- Sundberg WJ. 1967. The family *Lepiotaceae* in California. – Master's thesis, San Francisco. 219 pp.
- Sundberg WJ. 1971a. A new species of *Lepiota*. *Mycologia* 63: 79–82.
- Sundberg WJ. 1971b. The genus *Chlorophyllum* (*Lepiotaceae*) in California. *Madroño* 21: 15–20.
- Sundberg WJ. 1976. *Lepiota* sensu lato in California. II. Type studies of *Lepiota cupressea* and *Lepiota marginata*. *Mycotaxon* 3: 381–386.
- Sundberg WJ. 1989. *Lepiota* sensu lato in California III. Species with a hymeniform pileipellis. *Mycotaxon* 34: 239–248.
- Sundberg WJ. 1995. A type study of *Lepiota pulverapella*. *Doc. Mycol.* 25 (98–100): 449–451.
- Vellinga EC. 2001a. Studies in *Lepiota* III. Some species from California, U.S.A. *Mycotaxon* 80: 285–296.
- Vellinga EC. 2001b. Studies in *Lepiota* IV. *Lepiota cristata* and *L. castaneidisca*. *Mycotaxon* 80: 297–306.

- Vellinga EC. 2001c. *Leucocoprinus*. In Noordeloos M. E., Kuyper Th. W., Vellinga E. C. (eds). Flora agaricina neerlandica 5: 76–84. A.A. Balkema Publishers, Lisse/Abingdon/Exton (PA)/Tokyo. 169 pp.
- Vellinga EC. 2004a. Ecology and distribution of lepiotaceous fungi – a review. Nova Hedwigia 78: 273–299.
- Vellinga EC. 2004b. Genera in the family *Agaricaceae* – Evidence from nrITS and nrLSU sequences. Mycological Research 108: 354–377.
- Vellinga EC. 2007a. Lepiotaceous fungi in California, U.S.A. – 2. *Lepiota rhodophylla*. Mycotaxon 98: 205–211.
- Vellinga EC. 2007b. Lepiotaceous fungi in California, U.S.A. – 3. Pink and lilac species in *Leucoagaricus* sect. *Piloselli*. Mycotaxon 98: 213–224.
- Vellinga EC. 2007c. Lepiotaceous fungi in California, U.S.A. – 4. Type studies of *Lepiota fumosifolia* and *L. petasiformis*. Mycotaxon 98: 225–232.
- Vellinga EC. 2007d. Lepiotaceous fungi in California, U.S.A. – 5. *Lepiota oculata* and its look-alikes. Mycotaxon 102: 267–280.
- Vellinga EC. 2009. Nomenclatural overview of Lepiotaceous fungi. Version 4.4 2/4/2009: http://plantbio.berkeley.edu/~bruns/ev/vellinga_nomencl_v47_feb2009.pdf (Accessed 5/19/2009).
- Vellinga EC, Davis RM. 2007. Lepiotaceous fungi in California, U.S.A. – 1. *Leucoagaricus amanitoides*. Mycotaxon 98: 197–204.
- Vellinga EC, Noordeloos ME. 2001. Glossary In Noordeloos ME, Kuyper ThW, Vellinga EC (eds). Flora agaricina neerlandica 5: 6–11. A.A. Balkema Publishers, Lisse/Abingdon/Exton (PA)/Tokyo. 169 pp.
- Vellinga EC, Sundberg WJ. 2007. Lepiotaceous fungi in California, U.S.A.–6. *Lepiota castanescens*. Mycotaxon 103: 97–108.
- Zeller SM. 1922. Contributions to our knowledge of Oregon fungi-I. Mycologia 14: 173–199.
- Zeller SM. 1929. Contributions to our knowledge of Oregon fungi-III. Mycologia 21: 97–111.
- Zeller SM. 1933. New or noteworthy agarics from Oregon. Mycologia 25: 376–391.
- Zeller SM. 1934. A new species of *Lepiota*. Mycologia 26: 210–211.
- Zeller SM. 1938. New or noteworthy agarics from the Pacific coast states. Mycologia 30:468–474.

Type studies and nomenclatural revisions in *Parasola* (Psathyrellaceae) and related taxa

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Abstract — Basidiomycetes belonging in the genus *Parasola* and some satellite taxa have been revised on the basis of type studies and original diagnoses. As a result of an extensive taxonomic survey, 34 names affiliated with *Parasola* (formerly *Coprinus* subsections *Glabri* and *Auricomi*) have been identified. Type materials of 15 taxa have been found in various herbaria and examined. These taxa are described and their basidiospores, basidia, cheilocystidia, pleurocystidia, and pileipelli illustrated. The results support *P. leiocephala* as a synonym of *P. lactea*. An epitype for *P. plicatilis* and a neotype for *P. misera* are designated and illustrated in detail. *Parasola auricoma* is lectotypified. *Pseudocoprinus besseyi* and *C. elongatipes* are synonymized with *P. auricoma*. The type of *P. galericuliformis* represents an immature *P. lactea*. *Coprinus plicatilis* var. *filopes* is a later synonym of *P. lactea*. *C. longipes* and *C. rimosus* are synonymized with *P. schroeteri*, while *Pseudocoprinus brunneolus* belongs to *P. lactea*. Where possible, our conclusions were confirmed by molecular phylogenetic analyses.

Key words —synonymization, deliquescence

Introduction

The genus *Parasola* Redhead et al. (formerly *Coprinus* subsection *Glabri* and *Auricomi*) comprises coprinoid taxa that lack veils and caulocystidia and have parasol-like, non-deliquescent pilei (Doveri 2004, Orton & Watling 1979, Redhead et al. 2001, Uljé & Bas 1985). Nagy et al. (2009) have recently referred to the process of fruitbody maturation observed in *Parasola*, which differs from both “true” deliquescence and non-deliquescence, as “collapsing”, in order to avoid confusion with non-deliquescent coprinoid and *Psathyrella* taxa. Although many widely distributed, well-known taxa belong here, such as *P. plicatilis* (Curtis) Redhead et al. or *P. leiocephala* (P.D. Orton) Redhead et al., taxonomic delimitation is still problematic and much confusion surrounds most species.

Redhead et al. (2001) recognized 18 taxa in the genus *Parasola*, resurrecting a number of taxa forgotten in the recent literature, such as *Coprinus mirabilis*,

C. pachyterus, *C. setulosus*, *Pseudocoprinus lacteus*, *Ps. brunneolus*, etc. Many of these, however, are known only from the type collections. Furthermore, in the cases of *C. mirabilis*, *Ps. lacteus*, *Ps. besseyi*, and *Ps. brunneolus*, no modern description or type study was available, so it has been impossible to come to any conclusion concerning status. In the present study, we have revised all available type materials and validly published names of “collapsing” taxa that belong to, or have been affiliated with, the genus *Parasola* or *Coprinus* subsection *Glabri* and *Auricomi*. Taxa with missing or unavailable types have also been revised based on their original descriptions.

Materials and methods

Attempts were made to locate type materials of all validly published names connected with *Parasola* or *Coprinus* subsection *Glabri* and *Auricomi*. Types of 15 taxa were obtained on loan. Where we did not succeed in locating or obtaining the type specimens on loan, we base our comments exclusively on the original description. Despite repeated attempts, we were unable to obtain type material of *P. subprona* (Cleland) J.A. Simpson & Grgur. and *P. virgulacolens* (Cleland) J.A. Simpson & Grgur. on loan. ‘Non-collapsing’ *Parasola* taxa, i.e. *P. conopila* and its close allies (Larsson & Örstadius 2008, Padamsee et al. 2008, Vasutová et al. 2008) are not considered here.

As there is no type collection for the widely known taxon, *P. misera*, we selected a neotype to stabilize its nomenclatural status by adhering to the following criteria: (i) the neotype should accord with the original description as closely as possible; (ii) if the original description is not sufficiently diagnostic, the neotype should conform to the currently most widely-accepted usage of the name, unless this contradicts the original description; (iii) the neotype should be typical of the taxon it intends to represent; and (iv) a rich, complete collection should be selected that allows examination of all taxonomically important features. We did not attempt to select collections that originated from the type locality of the holotype. This may be important if it is presumed (e.g., from molecular studies) that the taxon is composed of many cryptic species, resulting from allopatric speciation. Neither morphological nor molecular studies (Nagy, unpublished results) suggest cryptic speciation in *P. misera*. Types have been deposited in BP, and parts of the type materials can be found in SzMC (Szeged Microbiological Collection).

All anatomical observations were made from dried material, except in the cases of the neotype of *P. misera* and the epitype of *P. plicatilis*, which were macroscopically annotated from fresh material. Before examination, herbarium materials were revived in 10% KOH, then mounted with Congo Red in NH_4OH . Unfortunately, many types were in poor condition because of their age and/or fruiting bodies poorly preserved by the collector. At times, most of the important features had collapsed, and only basidiospores could be observed. To mitigate the effects of partially collapsed fruitbodies we applied a longer treatment in 10% NH_4OH solution: up to 1.5–2 hours. This gave improved dissection in many cases.

Drawings of microscopic characters are based on microphotographs. Measurements were made at $\times 1000$ with a calibrated optical micrometer. Basidiospore measurements are based on at least 20 samples from each collection. The numbers in square brackets

after the word „Basidiospores” refer to the number of spores measured, the number of fruiting bodies examined, and the collections they originate from, respectively. Spore measurements are given as follows: length range \times breadth range \times width range. Q values were calculated as follows: Q_1 = length divided by breadth; Q_2 = length divided by width. Measurements of basidia included sterigmata. Pleurocystidia and cheilocystidia were observed and measured by cutting the gill edge from the rest of the gill to avoid blending of the two cystidial types. The interpretation of microscopic details follow standard conventions (Vellinga 1988). Abbreviations of names of herbaria follow Holmgren et al. (1990).

Results

Our extensive literature search identified 34 names that (potentially) belong to the genus *Parasola*. Of the 34 names associated with *Parasola* or *Coprinus* subsection *Glabri* and *Auricomi*, we examined type collections representing 15 taxa: *C. pallidus*, *Agaricus leptosceles*, *C. galericuliformis*, *C. hercules*, *C. kuehneri*, *C. leiocephalus*, *C. lilatinctus*, *C. megaspermus*, *C. nudiceps*, *C. pachyterus*, *C. plicatilis* var. *filopes*, *C. schroeteri*, *C. setulosus*, *Pseudocoprinus besseyi*, and *Ps. lacteus*. Among the remaining 19 taxa, types of *C. plicatilis*, *C. elongatipes* and *C. miser* are missing, while for the other 16 we could not obtain or locate the type. Missing types were sought in several herbaria. We located type specimens of *C. virgulacolens* and *Psathyrella subprona* (in AD), but they were not available on loan. Comments on taxa with unavailable types are based on the original descriptions or type studies published by other authors (Grgurinovic 1997, Pegler 1986).

We have lectotypified *P. auricoma* to stabilize its nomenclatural status, epitypified *P. plicatilis*, and designated a neotype for *P. misera*. *Parasola leiocephala*, *P. galericuliformis*, and *Pseudocoprinus brunneolus* are synonymized with *Ps. lacteus*. Types of *Ps. besseyi* and *C. elongatipes* were found to be conspecific with *P. auricoma* and are proposed as synonyms of that species. *C. longipes* and *C. rimosus* turned out to be younger synonyms of *P. schroeteri*. The results of the type studies, herbarium details, and nomenclatural revisions are summarized in TABLE 1.

Type studies

Agaricus leptosceles Berk. & Broome, Journal of the Linnean Society, Botany 11: 558 (1871). FIG. 4–5.

ISOTYPE: Sri Lanka: Peradeniya, September 1868, G.H.K. Thwaites 770 (Berk. 1348) (K).

ORIGINAL DIAGNOSIS: *Pileo hemispherico, acute umbonato subtiliter tomentoso, usque ad umbonem striato, stipite gracili* (No. 770). On the ground. Peradeniya. Sept. 1868.

Pileus 1-inch across, striated up to the acute and elongated truncate umbo; stem 2.5–3 inches high, 1/2 line thick; gills ventricose, shortly adnate, spores egg-shaped, – 0003 long [0.0003 inches]. Allied to *A. hydrophorus*.

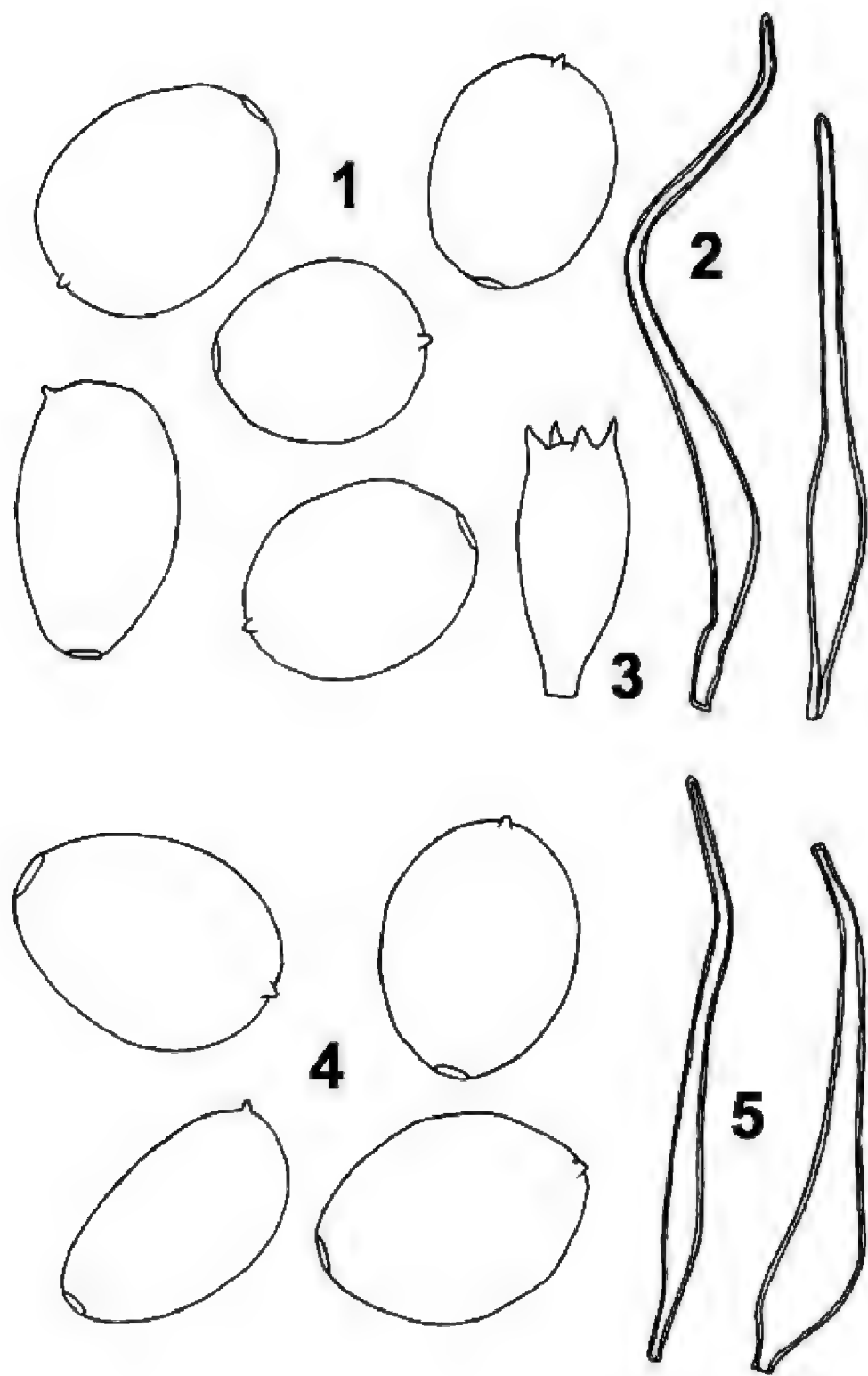


FIG. 1–5. Type material of *Coprinus pallidus* and *Agaricus leptosceles*.
Spores (1), basidium (2), and sclerocystidia (3) are depicted for *C. pallidus*.
FIGS. 4 and 5 represent spores and sclerocystidia of *A. leptosceles*, respectively

OBSERVATIONS ON THE TYPE—In the type envelope, there are 3 half fruiting bodies glued on a paper card, in a rather good state. Their pale-greyish pilei are more similar to dried *P. conopila* specimens, but the gills are more reminiscent of deliquescent *Parasola* taxa.

TABLE 1. Synopsis of the proposed nomenclatural changes and the status of taxa in the genus *Parasola*.

TAXON NAME	TYPE	NAME STATUS/ CURRENT NAME
<i>Agaricus leptosceles</i>	K	<i>P. setulosa</i>
<i>Agaricus plicatilis</i>	Lectotype & epitype (BP) selected here	<i>P. plicatilis</i>
<i>Agaricus subtilis</i>	?	Rejected name
<i>Coprinus auricomus</i>	Lectotype selected here	<i>P. auricoma</i>
<i>Coprinus elongatipes</i>	Not existent	<i>P. auricoma</i>
<i>Coprinus galericuliformis</i>	E	<i>P. lactea</i>
<i>Coprinus hansenii</i>	Not existent	<i>P. auricoma</i>
<i>Coprinus hemerobius</i>	Not existent	Rejected name
<i>Coprinus hercules</i>	L	<i>P. hercules</i>
<i>Coprinus kuehneri</i>	L	<i>P. kuehneri</i>
<i>Coprinus leiocephalus</i>	E	<i>P. lactea</i>
<i>Coprinus lilatinctus</i>	L	<i>P. lilatincta</i>
<i>Coprinus longipes</i>	?	<i>P. schroeteri</i>
<i>Coprinus megaspermus</i>	E	<i>P. megasperma</i>
<i>Coprinus mirabilis</i>	?	Rejected name
<i>Coprinus miser</i>	Neotype (BP) selected here	<i>P. misera</i>
<i>Coprinus miser</i> f. <i>marasmioides</i>	?PC	<i>P. misera</i>
<i>Coprinus nudiceps</i>	E	<i>P. schroeteri</i>
<i>Coprinus pachyterus</i>	K	?= <i>Coprinopsis vermiculifera</i>
<i>Coprinus pallidus</i>	K	<i>P. setulosa</i>
<i>Coprinus plicatilis</i> var. <i>filopes</i>	PRM	<i>P. lactea</i>
<i>Coprinus plicatilis</i> var. <i>microsporus</i>	?PC	<i>P. kuehneri</i>
<i>Coprinus plicatilis</i> var. <i>tenellus</i>	?GH or W	<i>Coprinopsis</i> sp.
<i>Coprinus proximellus</i>	Not in NY	Rejected name
<i>Coprinus pseudonycthemerus</i>	Probably not existent	? = <i>P. schroeteri</i>
<i>Coprinus rimosus</i>	Not in UC, MICH, WELT	<i>P. schroeteri</i> .
<i>Coprinus schroeteri</i>	H	<i>P. schroeteri</i>
<i>Coprinus setulosus</i>	K	<i>P. setulosa</i>
<i>Coprinus sulphureus</i>	?	? = <i>P. auricoma</i>
<i>Coprinus virgulacolens</i>	AD	Rejected name
<i>Psathyrella subprona</i>	AD	? = <i>P. megasperma</i>
<i>Pseudocoprinus besseyi</i>	MICH	<i>P. auricoma</i>
<i>Pseudocoprinus brunneolus</i>	?CFMR	<i>P. lactea</i>
<i>Pseudocoprinus lacteus</i>	MICH	<i>P. lactea</i>

BASIDIOSPORES [20,1,1] $9.3\text{--}12.6 \times 7.6\text{--}9.8 \times 6.3\text{--}7 \mu\text{m}$, on average $10.8 \times 8.6 \times 6.7 \mu\text{m}$, $Q_1 = 1.17\text{--}1.43$, $Q_2 = 1.47\text{--}1.54$ lentiform, in the frontal view ovoid-subglobose, some slightly rounded triangular, with an obtuse apex, which may seem concave in some cases due to the large germ-pore, and more or less obtuse base, some with a more acute base (like *Panaeolus acuminatus* (Schaeff.) Quél.), in the lateral view ellipsoid, germ-pore central, $1.8\text{--}2 \mu\text{m}$ wide; BASIDIA, CHEILOCYSTIDIA, and PLEUROCYSTIDIA not observable; PILEIPELLIS collapsed, with scarce, thick-walled lageniform hairs, ca. $120\text{--}130 \times 5\text{--}10 \mu\text{m}$.

Several papillate subglobose spores found on the cap cuticle do not belong to this fungus.

REMARKS—On the basis of the presence of thick-walled hairs on the pileus and the lentiform spores with a central germ-pore, this taxon is identical with *P. setulosa*, another taxon described from the same place at the same time, a fact already noted by Pegler (1986). As in *C. pallidus*, the only difference between *A. leptosceles* and *P. setulosa* is the much larger sclerocystidia, found in the type of the latter species.

Coprinus galericuliformis Losa ex Watling, Notes from the Royal Botanic Garden, Edinburgh 28: 42 (1967). FIGS. 6–9.

HOLOTYPE: United Kingdom, Scotland: Edinburgh, Royal Botanic Garden, 14 May 1966, Watling 26310 (E).

ORIGINAL DIAGNOSIS: *Pileus primo glandiformis vel ellipticus altus, 6–15 mm vix expansus clare fulvo-ochraceus vel ferrugineo-mellinus vulgo ad discum obscurius coloratus. Stipes 10–35 × 2–3 mm, subaequalis ad basim leviter incrassatus, albus. Caro concolorata siccitate intus albida. Lamellae fere liberae ex albo albida vel cacinae dein nigro-umbrinae; basidia 4-sporigera; basidiosporae 10.5–12.5 × 10–11 × 5–7 μm lentiforme poro germinativo. Cheilocystidia ellipsoideo-vesiculosa. Pleurocystidia et velum absentia.*

OBSERVATIONS ON THE TYPE—The holotype, which is in a good state, contains numerous fruiting bodies in different stages of maturity.

BASIDIOSPORES [20,1,1] $10\text{--}12 \times 9.8\text{--}10.9 \times 5.3\text{--}7.2 \mu\text{m}$, on average $11.68 \times 10.31 \times 5.96 \mu\text{m}$, $Q_1 = 1.02\text{--}1.25$, $Q_2 = 1.66\text{--}2.10$, strongly lentiform, in the frontal view broadly ovoid to subglobose, more rarely angular or rounded triangular, in the lateral view ellipsoid or amygdaliform, with an up to $1.8 \mu\text{m}$ wide, eccentric germ-pore, mainly immature, medium dark reddish brown, smooth, with a moderately thick wall; BASIDIA four-spored, clavate, $22\text{--}27 \times 8.5\text{--}11 \mu\text{m}$; CHEILOCYSTIDIA abundant, lageniform, utriform or subcylindrical, $19\text{--}53 \times 12\text{--}30 \mu\text{m}$; PLEUROCYSTIDIA utriform, oblong or cylindrical, $40\text{--}82.5 \times 15\text{--}27 \mu\text{m}$; PILEIPELLIS hymeniform; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—On the basis of the shape and the size of the basidiospores, this collection belongs to *P. lactea* (*P. leioccephala*). The holotype fruitbodies are

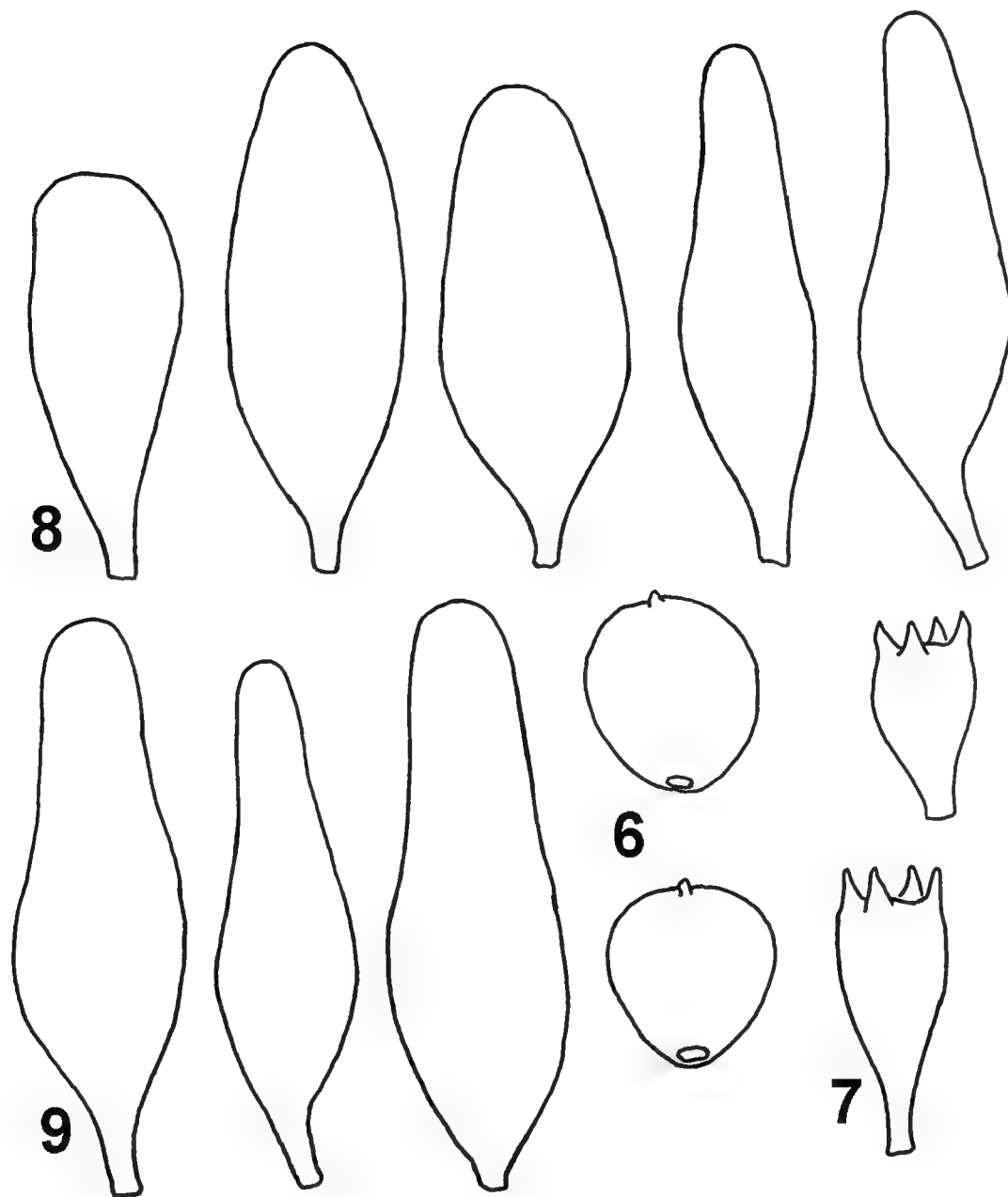


FIG. 6–9. Spores (6), basidia (7), cheilo- (8), and pleurocystidia (9) from the type of *C. galericuliformis*.

imperfectly matured, which causes the basidiospores to be more globose than typical in *P. lactea*. In our experience, the basidiospores reach their final rounded triangular or angled shape in the last stage of development, and accordingly no taxonomic value can be assigned to subglobose basidiospores in this case. Specimens with subglobose spores have recently been included in ITS- and LSU-sequence based phylogenetic analyses. With strong support from Bayesian, Maximum Likelihood, and Maximum Parsimony analyses, they were nested in the clade formed by *P. lactea* specimens (Nagy et al. 2009). That study strongly suggests that subtle spore shape differences should be regarded cautiously and that spore size should be given higher priority in defining the taxa of *Parasola*.

According to the original description (Watling 1967), the pleurocystidia are lacking, a statement that we cannot confirm here. Numerous utriform–oblong pleurocystidia were found on the sides of the gills. A lack of pleurocystidia would be surprising, as all but one collapsing species (*P. misera*) of *Parasola* possess pleurocystidia.

Roux & Garcia (Roux 2006) recently treated *P. galericuliformis* (and *P. leioccephala*) as a variety of *P. plicatilis*. However, our molecular and morphological results suggest that *P. galericuliformis* is synonymous with *P. lactea* (= *P. leioccephala*) a species distinct from *P. plicatilis* (Nagy et al. 2009).

Coprinus hercules Uljé & Bas, Persoonia 12: 483 (1985).

FIG. 10.

HOLOTYPE: The Netherlands: Leiden, 10 August 1984, C.B. Uljé (L).

ORIGINAL DIAGNOSIS: *Pileus* primo campanulatus vel hemisphaericus, dein convexus vel applanatus, 8–14(–17) mm latus, sulcatus usque ad centrum, brunneus vel pallide brunneus, postea cinerascens, nudus. Lamellae liberae, subdistantes ($L = 16\text{--}24$; $l = 0\text{--}1\text{--}3$), ex albo cinerascens vel nigricantes. Stipes 48–71 \times 0.6–1.2 mm, sursum subattenuatus, albidus, subvitreus, glaber, fragilis, basi subbulbosus. Sporae 12.4–17.2 \times 11.3–15.2 \times 8.2–10.8 μm , valde lentiformes, subtriangulatae vel subquinque-angulatae, poro germinativo excentrico instructae, obscure rubro-brunneae (fere nigrae), in cumulo purpureo-nigrae; basidia 4-sporigera. Cheilocystidia vesiculosa vel late utriformia, usque ad 50(–70) μm longa. 10–23(–30) μm lata. Pleurocystidia subutriformia vel subcylindrica, usque ad 105 μm longa, 22–30 μm lata. Pileipellis hymeniformis. Fibulae praesentes.

OBSERVATIONS ON THE TYPE—The holotype contains several well-preserved, but old, fruiting bodies. Unfortunately, all microscopic cells have collapsed except the basidiospores.

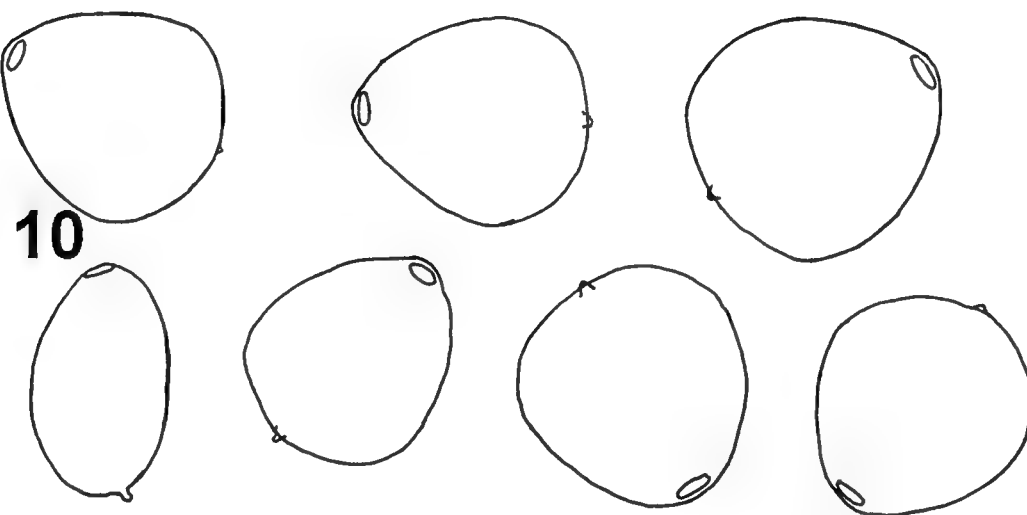


FIG. 10. Spores from the type of *C. hercules*.

BASIDIOSPORES [20,1,1] 13.8–17.5 \times 14.8–16.9 \times 10–11 μm , on average 15.83 \times 15.42 \times 10.63 μm , $Q_1 = 0.9\text{--}1.15$, $Q_2 = 1.4\text{--}1.5$; strongly lentiform, in the frontal view rounded triangular or quadrangular, more rarely subglobose or ovoid, in

the lateral view ellipsoid to amygdaliform, with a strongly eccentric, 2.6–2.7 μm wide germ-pore, color very dark reddish-brown, almost blackish, opaque, smooth, with a moderately thick wall; BASIDIA, PLEURO-, and CHEILOCYSTIDIA collapsed; PILEIPELLIS hymeniform; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—The diminutive fruitbody size and the low number of lamellae could also be observed on the type. According to the general view (Uljé & Bas 1985, 1988, Vila & Rocabrana 1996), these are diagnostic features that distinguish *P. hercules* from *P. schroeteri*. In our experience, *P. schroeteri* is macromorphologically a very variable species, and poorly developed small fruitbodies can be encountered. Furthermore, habitat preferences cannot be considered diagnostic, as both *P. schroeteri* and *P. hercules* also occur on both dung and soil. Therefore, we assign diagnostic value only to the size of the spores. The distinction of *P. hercules* from *P. schroeteri*, however, is strongly supported by molecular results (Nagy et al. 2009).

Coprinus kuehneri Uljé & Bas, Persoonia 13: 438 (1988).

FIGS. 11–15.

HOLOTYPE: The Netherlands: prov. Zuid-Holland, Leiden, park Leiden-Noord. 31 May 1987., C.B. Uljé (L).

ORIGINAL DIAGNOSIS: *Pileus ad 35 mm latus, sulcatus, obscure rubrobrunneus, interdum autantiobrunneus vel flavobrunneus, postea cinerascens, glaber. Lamellae stipite remotae, primo albidae, dein griseobrunneae vel atrogriseae. Stipes ad 100 × 3 mm, sordide albidus vel sordide albobrunneus. Sporae 6.5–10.5 × 5.5–8 × 5–6 μ , $Q = 1.05–1.6$, $Q = 1.16–1.45$, cordiformes, ad rhombeae vel mitriformes inclinatae, 3–4-, raro 5 angulatae, poro germilani excentrico praeditae. Cheilocystidia 30–80 × 12–28 μ , collo 11–23 μ lata, cylindrica vel utriformes, interdum sublageniformes vel elongato-ellipsoidea, raro fere solum globosa. Pleurocystidia 40–100 × 22–40 μ , collo 21–30 μ lata, plus minusve cheilocystidiis similia. Fibulae adsunt.*

OBSERVATIONS ON THE TYPE—The holotype is a good collection, containing many fruiting bodies, both young and old. All microscopic details could be observed on the material.

BASIDIOSPORES [20,1,1] 8–10.4 × 7.2–8.4 × 5.4–6.3 μm , on average 9.36 × 7.85 × 5.9, $Q_1 = 1.12–1.28$ $Q_2 = 1.45–1.60$, strongly lentiform, in the frontal view (narrowly) ovoid to rounded triangular, some with rhomboidal outline, in the lateral view amygdaliform, with an eccentric, ca 1.5 μm wide germ-pore, dark reddish-brown, almost opaque in NH_4OH , smooth, with a moderately thick wall; BASIDIA four-spored, dimorphic, 27–40 × 8–10 μm ; CHEILOCYSTIDIA abundant, very variable in shape and size, mainly cylindrical-utriform with some clavate or fusoid ones, 39–75 × 12–31.2 μm ; PLEUROCYSTIDIA numerous, predominantly cylindrical, a few broadly fusoid and ellipsoid, some with an enlarged apex, 55–113 × 21–33 μm ; PILEIPELLIS a hymeniderm; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

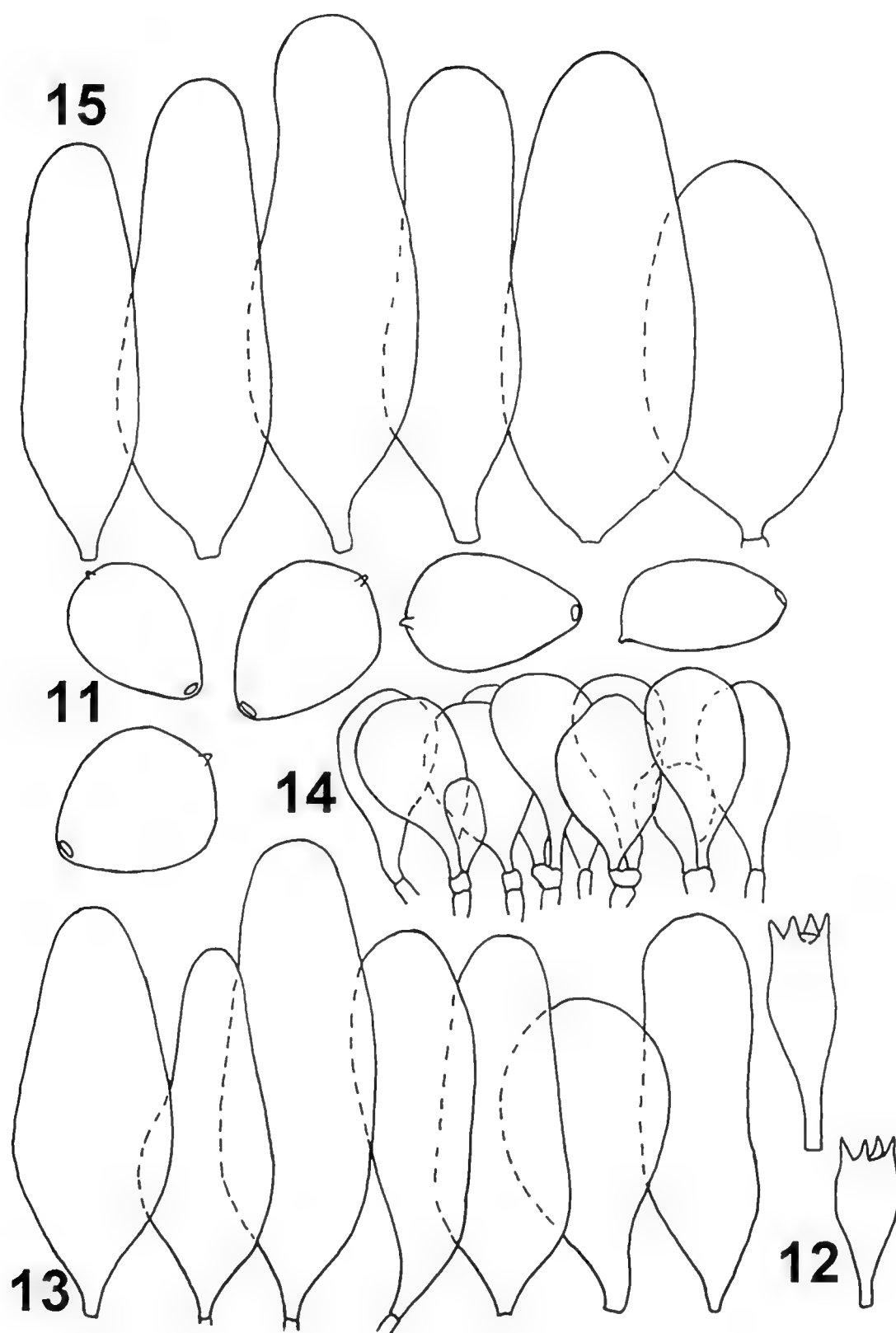


FIG. 11–15. Type material of *C. kuehneri*.
Spores (11), basidia (12), cheilo- (13), and pleurocystidia (15),
as well as pileipellis structure (14) could be observed.

REMARKS—The spore size seems to be slightly too large as compared with other materials of this species (Nagy, unpubl.). Our observations in part contradict the original description (Uljé & Bas 1988) with regard to the size range of the

spores. We think that the explanation of this difference in spore sizes is because Uljé & Bas (1988) measured several immature spores as well.

Coprinus leiocephalus P.D. Orton, Notes from the Royal Botanic Garden, Edinburgh 29: 88 (1969).

FIG. 16.

HOLOTYPE: Scotland: Wheatfen, Surlingham, Norfolk, 18 Sept. 1965. Orton 2566 (E).

ORIGINAL DIAGNOSIS: *Pileus* juventute 5–15 mm altus, 4–13 mm latus, dein 13–32 mm, ovoideus vel ellipsoideus dein conico-convexus, postremo expanso-convexus interdum ad discum depressus, castaneus, fulvo-brunneus vel ochraceo-mellinus ad discum obscuriore vel fulvo tinctus, siccitate pallide ochraceus vel sordide cremeus ad discum ochraceo-luteolobrunneus, rufo-brunneus vel fuscus, senectute circa marginem griseascens et radiliter sulcato-striatus, ad discum persistente laevis. Lamellae liberae, remotae, anguste lanceolatae, ex albido griseae vel colore pilei tinctae, postremo nigrescentes, vix confertae, L c. 32–40, l 0–1, ad aciem primo albo-flocculosae. Stipes (30)62–74(90)/1–2 mm, aequalis vel sursum leviter attenuatus, ex albo vel albido deorsum ochraceo-lutescens vel rufo-brunnescent; glaber, opacus, cavus, fragilis, ad basim albo tomentosus vel strigosotomentosus. Caro tenuissima, ad discum colore pilei concolorata. Odor nullus.

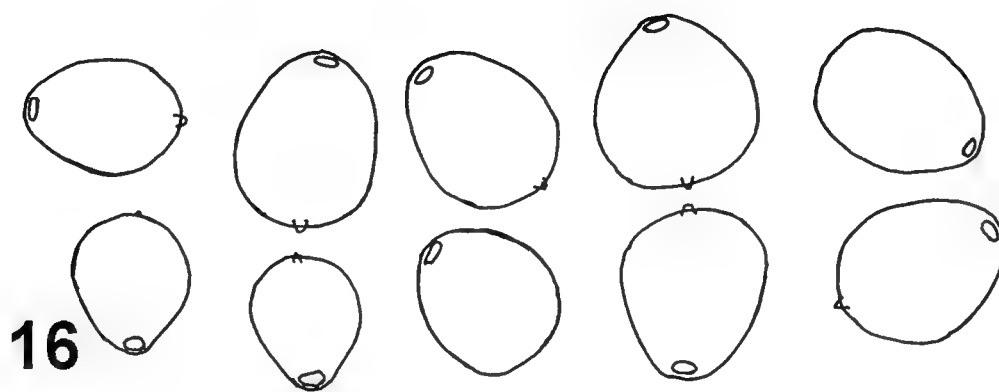
Sporae lentiformes, ellipsoideae vel ovoideae leviter angulatae, poro germinativo excentrico aliquantum amplo, 8.5–11/5.5–6.5/7–8.5 μm (FIG. 1, g), sub micr. obscure rufo-brunneo, in cumulo fere nigrae. *Cystidia* aciei lamellarum vesiculoso-clavata 30–42/16–32 μm , vel lageniformia ad apicem obtusa, 50–84(–92)/12–32 μm ad apicem 10–18(–24) μm lata. *Cystidia* faciei lamellarum vesiculose-clavate, pyriformia vel utriforme-lageniformia ad apicem obtuse lata c. 50–90/16–42 μm . *Cellulae cuticulae* pilei globosae vel ellipsoideae, setulae nullae.

Ad terram, solitarius vel catervatim, vulgo in locis humidis: Shobdon Herefordshire, 24 Oct. 1959; Wheatfen, Surlingham, Norfolk, 18 Sept. 1965, P.D. Orton. (typus in Herb. Kew.); ad solum vel ad lignam purridissimam solitarius vel subcaespitosus, Freshfield, Lancs., 16 Sept. 1959. A sporis et probabilitate habitatione distinguitur.

OBSERVATIONS ON THE TYPE—The holotype contains mature, well-preserved fruiting bodies; unfortunately, however, only spores and incomplete, collapsed basidia could be observed.

BASIDIOSPORES [30,1,1] 9.5–12 \times 8.4–9.5 \times 6.2–7 μm , on average 10.73 \times 8.81 \times 6.73 μm , $Q_1 = 1.06$ –1.32, $Q_2 = 1.57$ –1.79 strongly lentiform, in the frontal view mainly ovoid, rarely rounded triangular, subhexagonal or subglobose, mostly with a rounded apex, rarely subpapillate, in the lateral view ellipsoid, with a moderately thickened wall, germ-pore eccentric, ca. 1.8 μm in diameter, color very dark reddish-brown, subopaque, smooth, with moderately thick wall; BASIDIA four-spored, clavate, bimorphic, mainly collapsed; PLEUROCYSTIDIA and CHEILOCYSTIDIA collapsed; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—The basidiospores of the holotype mainly have an obtuse apex, in contrast to numerous other *P. leiocephala* collections cited as having basidiospores with an acute, often papillate end (Breitenbach & Kränzlin 1995, Lanconelli 2003, Orton 1972, Orton & Watling 1979, Uljé & Bas 1988, Uljé &

FIG. 16. Spores from the type of *C. leiocephalus*.

Bender 1997). Despite this discrepancy, the examined collection falls within the range of variability cited for this species. It is well known that *P. leiocephala* is an extremely variable species both macroscopically and microscopically (Ulje & Bas 1988, Ulje & Bender 1997, Nagy et al. 2009). Its spore shape ranges from markedly rounded triangular with distinct angles to subglobose with hardly visible angles. Further, spore shapes commonly vary considerably within a single fruiting body, showing different proportions of rounded and triangular spores (Nagy, unpubl.).

This species was recently reduced to varietal status under *P. plicatilis* (Roux 2006). There is, however, strong (phylogenetic) evidence in favour of treating *P. leiocephala* as a species separate from *P. plicatilis* (Nagy et al. 2009).

Coprinus lilatinctus Bender & Ulje, in Ulje & Bender, Persoonia 16: 373 (1997).

FIGS. 17–20.

HOLOTYPE: The Netherlands: Alphen a/d Rijn, prope Zegerplas, 27. August 1988, C.B. Ulje 987 (L).

ORIGINAL DIAGNOSIS: *Pileus junior usque ad 30 mm altus, 16 mm latus, cylindricus, ellipsoideus vel conicus, adultus ad 50 mm latus, junior distincte lilacino-tinctus, demum lilaceo-griseo-brunneus vel pallide griseo-brunneus vel griseus, glaber. Lamellae, L = 36–45, l = 1–3(–5), liberae, primo albae demum griseae vel atrae acie pallidior. Stipes usque ad 100 × 2–3 mm, versus basim incrassatus vel bulbosus, albus vel griseo-albus.*

Sporae 9.6–13.3 × 9.0–11.2 × 6.1–8.3 μm, 5-angulatae, cordiformes, poro germinativo excentrico praeditae. Basidia 20–45 × 9–12 μm, tetrasporigera. Cheilocystidia 25–70 × 12–28 μm, vesiculosa, ellipsoidea, obovoidea vel subcylindracea, interdum utriformia. Pleurocystidia 30–95 × 22–38 μm, vesiculosa, subcylindracea, ellipsoidea vel subutriformia. Fibulae presentes. Pileipellis hymeniformis e elementis clavatis vel vesiculososis. Elementae microscopicae, praesertim in pilei-pelle vel hymenio cum granulae griseo-alutaceae. Ad terram argillaceam vel ad fragmentam lignam, gregarius.

OBSERVATIONS ON THE TYPE—The holotype consists of several fruiting bodies, including young and mature ones, perfectly preserved. No trace of a lilaceous tint was seen on the fruiting bodies, and they were slightly more golden-yellow than usual in *P. lactea*.

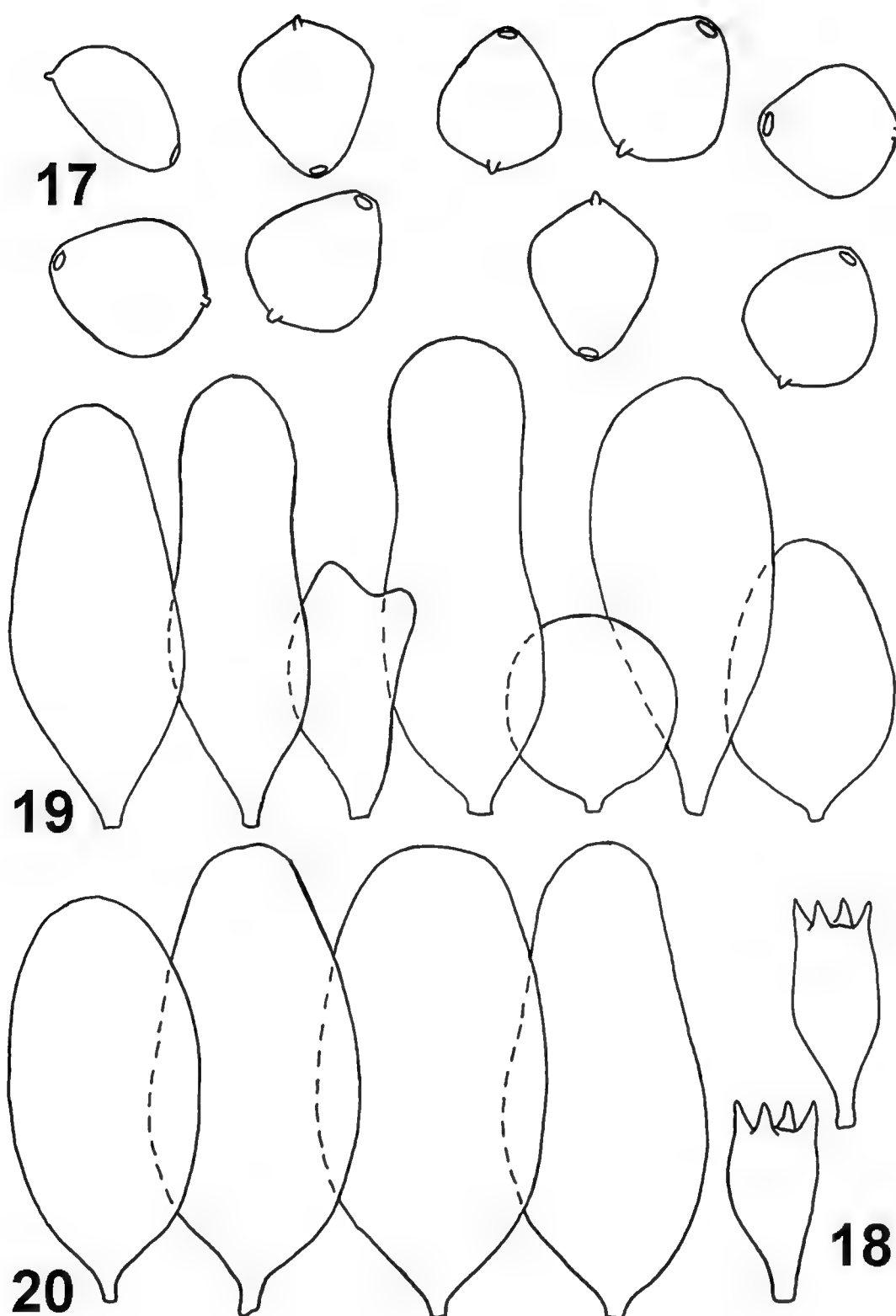


FIG. 17–20. Spores (17), basidia (18), cheilo- (19), and pleurocystidia (20) from the holotype of *C. lilatinctus*.

BASIDIOSPORES [20,1,1] $11\text{--}13.5 \times 9\text{--}10.8 \times 6.7\text{--}7.5\ \mu\text{m}$, on average $12.01 \times 9.86 \times 7.35\ \mu\text{m}$, $Q_1 = 1.14\text{--}1.33$, $Q_2 = 1.6\text{--}1.75$ strongly lentiform, in the frontal view mainly quadrangular to rounded triangular, sometimes 5- or 6-angled, or ovoid, ellipsoid to amygdaliform in lateral view, with a strongly eccentric, $1.6\text{--}1.9\ \mu\text{m}$ wide germ-pore, smooth, with a moderately thick wall; BASIDIA

four-spored, clavate, bimorphic, surrounded by pseudoparaphyses, $22\text{--}34 \times 10\text{--}12 \mu\text{m}$; CHEILOCYSTIDIA abundant, versiform, mainly cylindrical, ellipsoid or oblong, more rarely utriform or globose, $27\text{--}49 \times 15\text{--}20 \mu\text{m}$; PLEUROCYSTIDIA subcylindrical, ellipsoid, oblong or obovoid, rather abundant, $50\text{--}67 \times 27\text{--}32 \mu\text{m}$; PILEIPELLIS hymeniform, glabrous; no droplets could be observed in the basidia, pseudoparaphyses or pileipellis elements; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—Although we could not find the yellowish droplets typical of *P. lilatincta* in the type, their original presence cannot be excluded. Both Uljé (in Uljé & Bender 1997, Uljé 2005) and we have repeatedly observed that these droplets disappear from the cells in older herbarium materials. Upon examination of other materials collected by Uljé at the same locality (e.g. *Uljé 1212*, preserved in L), we found traces of oily droplets, mainly in the pileipellis.

Similarly, although the lilaceous colouration could not be observed in the type material, many other specimens collected by Uljé exhibited lilaceous tints.

Coprinus megaspermus P.D. Orton, Notes from the Royal Botanic Garden, Edinburgh 32: 141 (1972).

FIG. 21.

HOLOTYPE: United Kingdom, England: Norfolk. Hedenham Wood, ad terram, 24. October 1971, Orton 4132 (E).

ORIGINAL DIAGNOSIS: *A sociis a sporis vix lentiformibus permagnis facile distinguitur.*

Pileus ovoideus, 11/12 mm, dein expansus ad discum depressus, 15–30 mm, juventute fere ferrugineus dein ad discum fulvus vel cinnamomeus et ad marginem versus argillaceo-luteolus et forte plicato-striatus, vix deliquescens circa discum senectute cinnamomeotinctus. Lamellae ± liberae, nigricantes, confertae, L= ca. 50, l= 0–1, ad aciem albidoflocculosae. Stipes 52–60/2 mm; aequalis vel ad basim leviter incrassatus, albus dein pallide argillaceo-luteolus, laevis, ad basim tomentosus. Caro ad discum pilei admodum crassa. Sporae ellipsoideae vel ellipsoideo-ovoideae interdum leviter lentiformes, $15\text{--}18/8.5\text{--}9.5/10\text{--}11 \mu\text{m}$ (FIG. 1.f), in cumulo nigro-umbrinae. Basidia 4-sporigera. Cystidia aciei lamellarum ± lageniformia, ca. $50\text{--}60/18\text{--}20 \mu\text{m}$, ad apicem conicum vel cylindrico-obtusum $8\text{--}10 \mu\text{m}$ latae. Cystidia faciei lamellarum non vidi. Cellulae cuticulae pilei $12\text{--}28 \mu\text{m}$ latae. Setulae et sphaerocystes desunt.

OBSERVATIONS ON THE TYPE—The holotype contains two, slightly fragmented mature fruiting bodies in good condition. All microscopic details have collapsed, except the basidiospores.

BASIDIOSPORES [26,1,1] $15\text{--}18.7 \times 10\text{--}12 \times 7.7\text{--}9 \mu\text{m}$, on average $16.5 \times 10.66 \times 8.5 \mu\text{m}$, $Q_1 = 1.40\text{--}1.78$, $Q_2 = 1.83\text{--}1.95$ strongly lentiform, in the frontal view ellipsoid, broadly ellipsoid, rarely ovoid, in the lateral view ellipsoid or subamygdaliform, germ-pore slightly eccentric, $2\text{--}2.3 \mu\text{m}$ wide, color very dark reddish brown, subopaque, smooth, with moderately thick wall; BASIDIA,

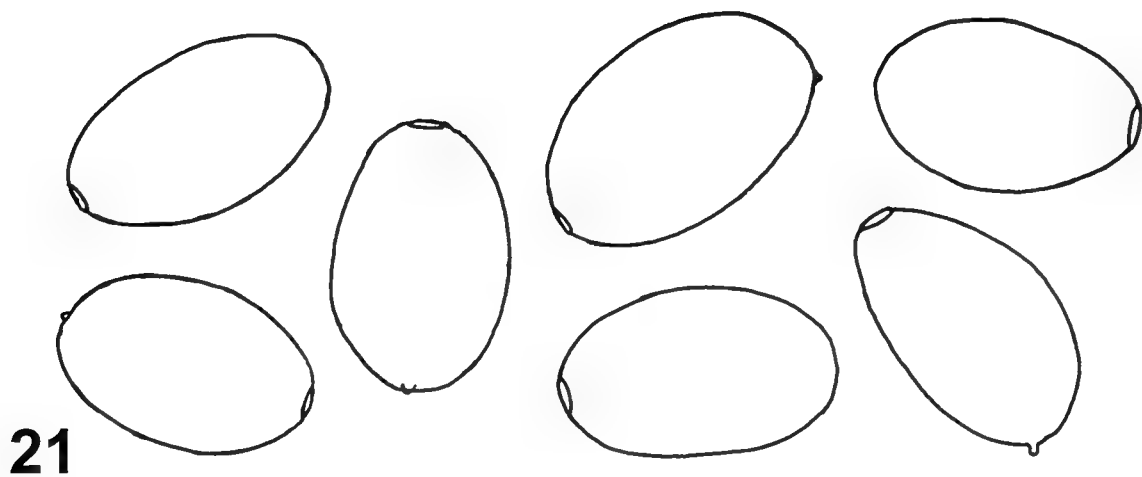


FIG. 21. Spores from the type of *C. megaspermus*.

PLEUROCYSTIDIA and CHEILOCYSTIDIA collapsed; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—The germ-pore in this collection is eccentric, albeit only slightly, which is in contrast with the finding of Orton (1972), who described the germ-pore as central. In fact, *P. megasperma* can have either a central or a more or less eccentric germ-pore, even in the same collection (Uljé & Bas 1988, Uljé 2005), so this discrepancy does not compromise the interpretation of this taxon. Phylogenetic analyses supported the view that the position of the germ-pore in this species is variable (Nagy et al. 2009).

Coprinus nudiceps P.D. Orton, Notes from the Royal Botanic Garden, Edinburgh 32: 142 (1972).

FIGS. 22–24.

HOLOTYPE: United Kingdom, Scotland: Inverness-shire. Tomich, ad fimum equinum, 3 September 1971, Orton 4133 (E).

ORIGINAL DIAGNOSIS: A *C. misero* sporis majoribus et habitu robustiore differt. Pileus ellipsoideus vel ovoideus 7–15/4–8 mm, dein expansus 9–24 mm interdum ad discum depressus, luteolus vel ochraceus dein ad discum fulvum vel cinnamomeum versus griseascens, primo laevis leviter nitidus, mox ad marginem dein ad discum versus sulcatus vel plicato-striatus, ad marginem postremo manifeste laceratus vel radialiter fissuratus. Lamellae liberae vel anguste adnatae, e pallide luteolo vel ochraceo mox umbrinae vel nigricantes, subconfertae, ad aciem primo albo-flocculosae. Stipes 30–60/0.5–1 mm, sursum attenuatus, leviter bulbosus (ad basim 1.5–3 mm latus) ex albido sordide cremeus vel cremeo-luteolofuscus, minute adpresse sericeostriatus, ad basim primo fibrillis albosericis manifestis obtectus. Caro pilei concolorata ad discum admodum crassa. Odor nullus.

Sporae lentiformes, ellipsoideo-ovoideae vel subgloboso-triangulares interdum leviter 5-vel 6-angulatae, 13–15.5/8.5–9.5/10–12 μm (FIG. 1.h), poro germinativo medio, in cumulo violaceonigrae. Basidia 4-sporigera. Cystidia aciei lamellarum pyriformia vel utriformia interdum irregulare vel late fusiformia vel vesiculosa, 30–60/14–28 μm . Cystidia faciei lamellarum non vidi. Cellulae cuticulae pilei 10–26 μm latae. Setulae et sphaerocystes desunt.

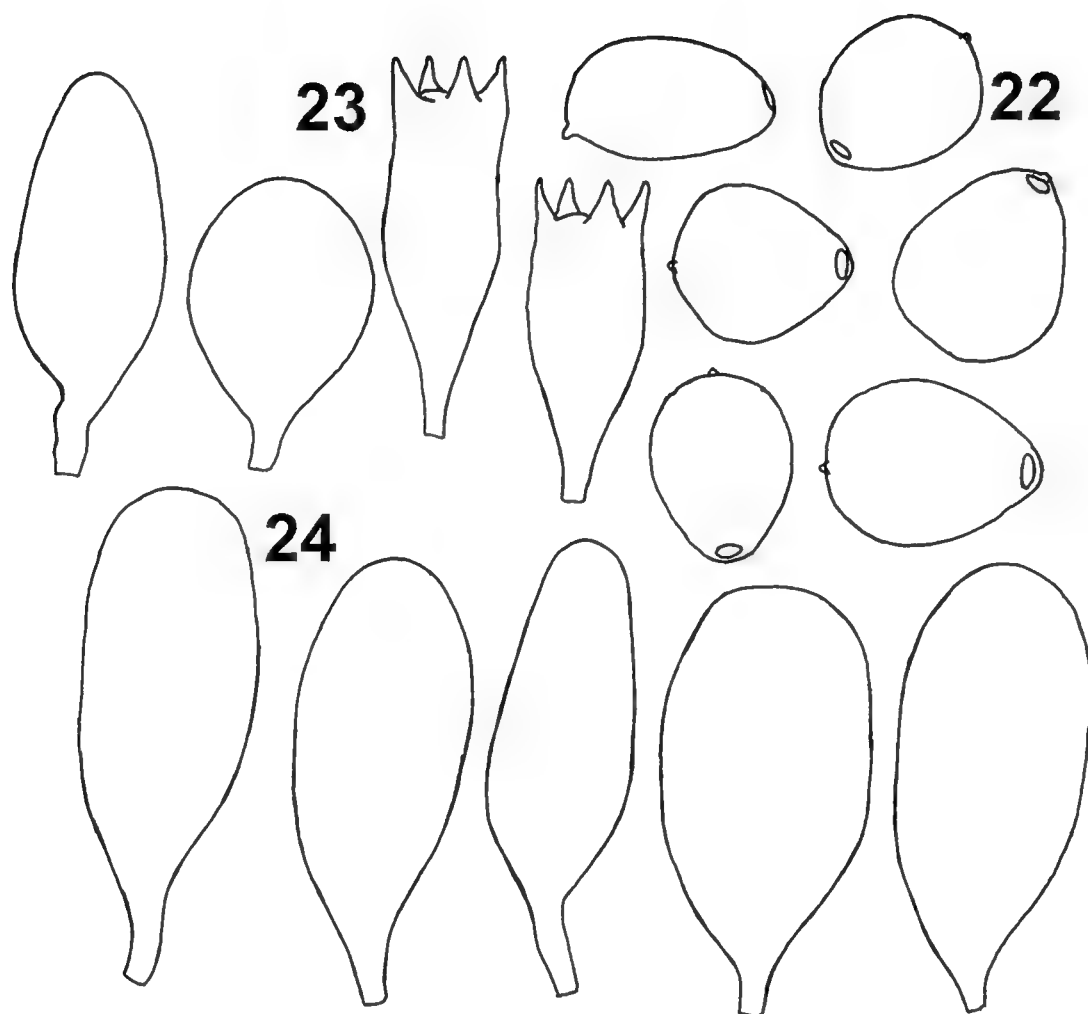


FIG. 22–24. Spores (22), basidia (23), and cheilocystidia (24) from type material of *C. nudiceps*.

OBSERVATIONS ON THE TYPE—The holotype contains both young and mature fruiting bodies, preserved in a very good state. All essential features could be observed except cheilocystidia, which were impossible to locate because of the fragmentation of the gill edges.

BASIDIOSPORES [22,1,1] $11.8\text{--}16 \times 11\text{--}13 \times 8.2\text{--}8.7 \mu\text{m}$, on average $13.94 \times 11.84 \times 8.45 \mu\text{m}$, $Q_1 = 1.07\text{--}1.37$, $Q_2 = 1.6\text{--}1.68$ strongly lentiform, in the frontal view broadly ovoid to rounded triangular, some ovoid, in the lateral view ellipsoid or slightly amygdaliform, wall moderately thickened, with a strongly eccentric ca. $2 \mu\text{m}$ wide germ-pore, smooth, with a moderately thick wall; **BASIDIA** four-spored, clavate, bimorphic $42\text{--}58 \times 10\text{--}15 \mu\text{m}$, surrounded by pseudoparaphyses; **PLEUROCYSTIDIA** abundant, from subglobose to ellipsoid, often utriform, $40\text{--}90 \times 32\text{--}40 \mu\text{m}$; **VEIL**, **PILEOCYSTIDIA**, **CHEILOCYSTIDIA**, and **CAULOCYSTIDIA** not found.

REMARKS—Our examinations of the type confirm the general view that *C. nudiceps* is a younger synonym of *P. schroeteri* (Breitenbach & Kränzlin 1995, Uljé & Bas 1988, Uljé & Bender 1997, Uljé 2005).

In the protologue, Orton (1972: 144) states that the germ-pore is central, which cannot be confirmed here. As Orton himself depicts correctly (Fig. 1g, p. 143), the germ-pore is eccentric as is typical for this species.

Coprinus pachyterus Berk. & Broome, Journal of the Linnean Society,
Botany 11: 561 (1871).

FIGS. 25–26.

ISOTYPE: Sri Lanka: Peradeniya, on soil. October 1868. Thwaites 806. (K).

ORIGINAL DIAGNOSIS: *Pileo persistenter campanulato plicato-sulcato; stipite firmiore; lamellis arcuatis adnexis.* (N° 806).

Hab. Ad terram, Peradeniya Ceylon (Thwaites)—*Pileus* 5 cm. *latus* glaber; *stipes* 6–8 cm. *longus*, *validior quam in C. plicatili.*

OBSERVATIONS ON THE TYPE—The holotype contains 4 entire fruiting bodies glued on paper cards. The specimens are in a rather good state.

BASIDIOSPORES [20,1,1] 11.5–13.8 × 7.3–8.2 × 6.8–7.8 µm, on average 12.61 × 7.81 × 7.2 µm, $Q_1 = 1.47$ –1.84, $Q_2 = 1.57$ –1.86 strongly lentiform, in the frontal view ellipsoid to oblong, in the lateral view amygdaliform, slightly flattened with a central, 1.5–1.8 µm wide germ-pore, dark blackish-brown, subopaque, smooth, with moderately thick wall; BASIDIA, PLEUROCYSTIDIA, and CHEILOCYSTIDIA collapsed; PILEIPELLIS in a poor state, cuticular; VEIL elements on pileipellis diverticulate, made up of dichotomously branched, coralloid elements 5–9 µm in diameter, terminal elements often inflated, clavate; excrescences mostly with acute tips; wall of velar elements hyaline, 1–3 µm thick in places; clamp connections present.

REMARKS—The material obtained on loan (coll. Thwaites 806) belongs to subsection *Alachuani* of the genus *Coprinus* s.l. by virtue of the diverticulate velar elements on the pileus and the cuticular pileipellis. In that subsection, it is apparently conspecific with *C. vermiculifer* (Joss. ex Dennis) Redhead et al. as this is the only species that combines large basidiospores with thick-walled velar elements (Josserand 1944, Uljé & Noordeloos 1996, 1997). The only difference between the types of *C. pachyterus* and *C. vermiculifer* that could be found is that *C. vermiculifer* grows on dung, based on the very limited number of collections known worldwide (Enderle et al. 1986, Uljé 2005, Uljé & Noordeloos 1996, 1997, Doveri 2004). This is of very limited value, however, considering the scarce information available on *C. vermiculifer*. Pegler (1986), who also studied the type and other collections of *C. pachyterus*, reported a hymeniform pileipellis, devoid of any veil-like structures. Further, he noted that the material consisted of two species; he referred one to *P. plicatilis* and the other to a taxon close to *P. hemerobia* (Fr.) Redhead et al. At present, *P. plicatilis* and *P. hemerobia* s. auct., which have a hymeniform pileipellis, are considered synonymous (Nagy et al. 2009, Uljé & Bas 1988, Uljé 2005, present work). However, the fungus that we examined clearly has an *Alachuani*-type veil and a

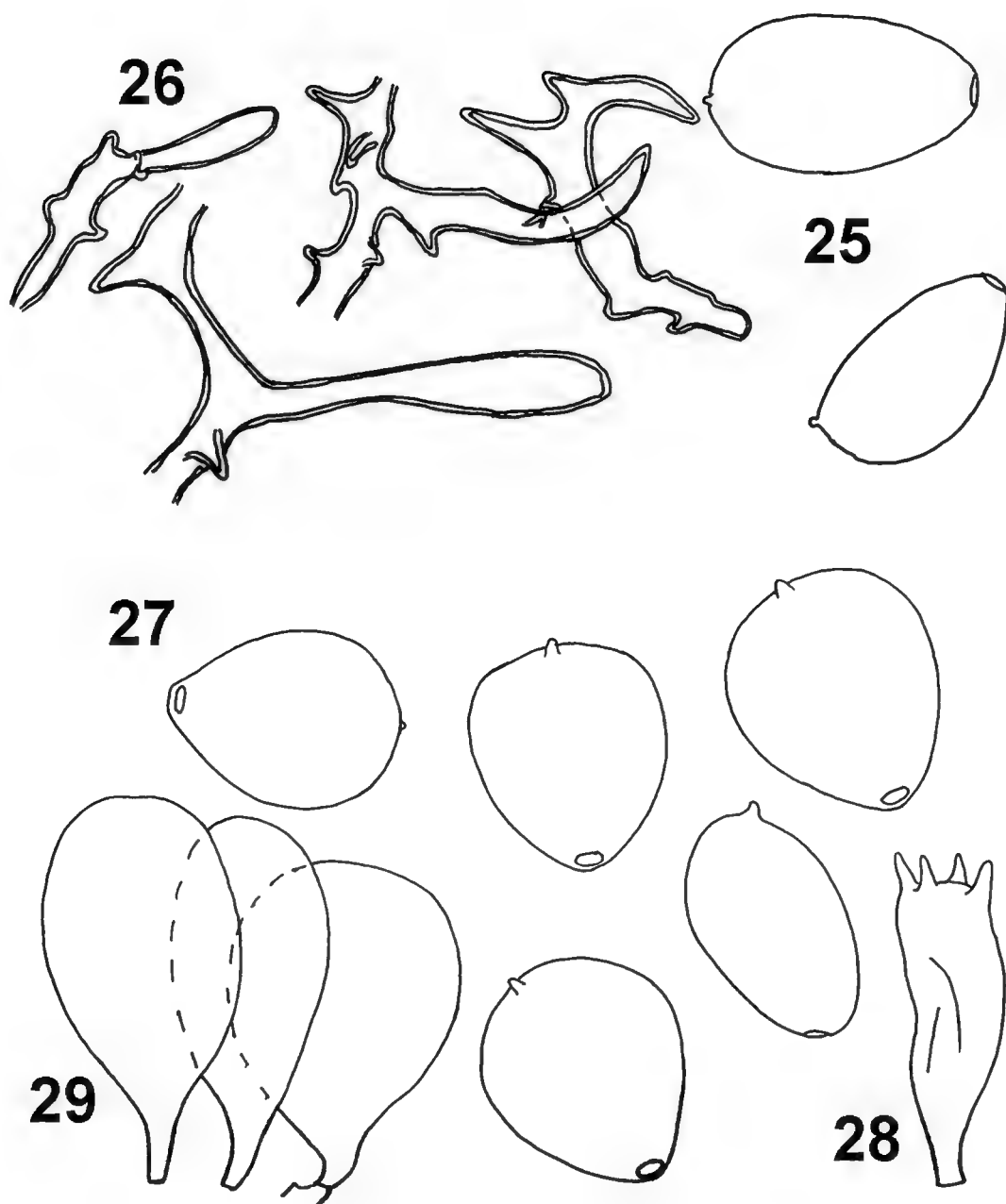


FIG. 25–29. *Coprinus pachyterus* and *C. plicatilis* var. *filopes*.

FIGS. 25 and 26 represent spores and velar elements of *C. pachyterus*.

For *C. plicatilis* var. *filopes* spores (27), a basidium (28), and pileipellis cells (29) are depicted.

cuticular pileipellis, which was confirmed by re-examination of the microscopic slide made from the type. Moreover, the shape of the spores (which tend to be oblong) and central germ-pore indicate that this specimen is more similar to *C. vermiculifer*. As it is questionable whether we obtained the same specimen on loan that Pegler (1986) examined, no further conclusions can be drawn.

Coprinus pallidus Berk. & Broome, Journal of the Linnean Society,
Botany 11: 560 (1871).

FIGS. 1–3.

ISOTYPE: Sri Lanka: on dead wood, September 1868. G.H.K. Thwaites 1157 (Berk. 1405)
(K).

ORIGINAL DIAGNOSIS: *Pileo inaequali subcylindrico pallido, disco laevi umbrino; stipite flexuoso fistuloso pallido; lamellis subliberis fuscis* (No. 1157, cum icone). On dead wood. July 1869.

Pileus 3 line across, 5 high, pale umber, disc even, much dark, its edges reflected; stem flexuous, 1.5 inches high, 1 line thick, fistulose, equal, smooth, pale umber, truncate at the base; gills 1 line wide, umber, then dark brown, slightly ventricose, nearly free; spores – 0003 [0.0003 inches] long.

OBSERVATIONS ON THE TYPE—The type material obtained from Kew contains one fruiting body in two parts, glued on a paper card and in a rather poor state. One part of the fruiting body is immature; the other parts are mature. Because of the poor state of the material, only spores, basidia, and sclerocystidia were observable. The hymenium seemed to be in good state, but cystidia were not found.

BASIDIOSPORES [20,1,1] $9\text{--}11 \times 7.5\text{--}8.6 \times 5.7\text{--}6 \mu\text{m}$, on average $9.7 \times 8.03 \times 5.7 \mu\text{m}$, $Q_1 = 1.08\text{--}1.32$, $Q_2 = 1.55\text{--}1.65$, lentiform, ovoid to subglobose with a rounded apex and base, not rounded triangular, but some tend to be minimally angular in the frontal view, ellipsoid, slightly amygdaloid in the lateral view, thick-walled, medium red-brown under the microscope, germ-pore central, rather small, $1.4\text{--}1.6 \mu\text{m}$; BASIDIA four-spored, clavate, bimorphic, ca. $22.5 \times 11 \mu\text{m}$; CYSTIDIA not found; PILEIPELLIS structure not observable, long, thick-walled, lageniform, brownish sclerocystidia present, these measure $87\text{--}150 \times 6\text{--}8 \mu\text{m}$.

REMARKS—The lentiform, ovoid spores combined with sclerocystidia on the pileus readily identify this species as *P. setulosa* (Berk. & Broome) Redhead et al., as already noted by Pegler (1986). The only discrepancy that we found between the types of *P. setulosa* and *C. pallidus* is that *P. setulosa* has extremely large, pike-like sclerocystidia, whereas those of *C. pallidus* are more like those of *P. auricoma*. However, *P. setulosa* is still insufficiently known to allow the assumption that this difference falls within the range of the variability for that species.

Coprinus plicatilis* var. *filopes Wichanský, Mykologický Sborník 45: 16 (1968).

FIGS. 27–29.

HOLOTYPE: Czech Republic: Prague, Kinského sady, Loco graminoso, 29. Sept., 1967, Wichansky (PRM).

ORIGINAL DIAGNOSIS: *A typo differt pileo tenerrimo maturitate plane explanato 7 mm diametro, lamellis angustis, distantibus, non diffluentibus, stipite hyalino, filiformi, usque 5 cm alto et 0.5 mm crasso.*

Auctor 2 specimina loco graminoso ad viam 29. IX. 1967 in horto publico Kinského sady dicto Pragae legit. Typus in herbario Musei nationalis Pragae depositus est.

OBSERVATIONS ON THE TYPE—The holotype envelope contains a small amount of material with fully mature pilei. Two other collections were also obtained on

loan (PRM 682556 and 682555), which were collected one year later at the same locality by Wichanský. They display similar features to those of the holotype but are also mature.

BASIDIOSPORES [20,1,1] $9.6\text{--}12 \times 8.6\text{--}10.3 \times 6.3\text{--}7 \mu\text{m}$, on average $10.93 \times 9.3 \times 6.77 \mu\text{m}$, $Q_1 = 1.09\text{--}1.30$, $Q_2 = 1.5\text{--}1.65$, strongly lentiform, in the frontal view mostly ovoid or rounded triangular, rarely rectangular, apex often subpapillate, in the lateral view ellipsoid, to subamygdaloid, with a $1.4\text{--}1.7 \mu\text{m}$ wide, eccentric germ-pore, dark reddish-brown, smooth, with moderately thick wall; BASIDIA mainly collapsed, four-spored, clavate, ca. $27 \times 10 \mu\text{m}$; PLEUROCYSTIDIA and CHEILOCYSTIDIA collapsed; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found; PILEIPELLIS hymeniform, composed of vesiculose-clavate elements, no pigment or oily granules observed, elements $25\text{--}37 \times 20\text{--}27 \mu\text{m}$.

REMARKS—The spores of the holotype clearly show that this taxon is synonymous with *P. lactea*. Indeed, the fruitbodies are smaller than normal in *P. lactea*, but this feature is of no taxonomic value at all in view of the considerable variability that can be encountered even within one collection.

Coprinus schroeteri P. Karst., Meddelanden af Societas pro Fauna et

Flora Fennica 5: 34. (1879).

FIG. 30.

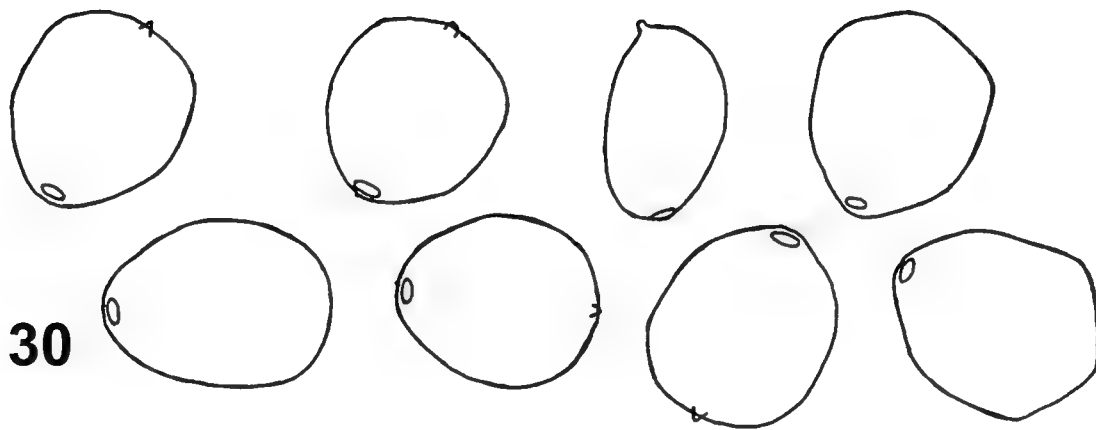
HOLOTYPE: Finland: Tavastia, Mustiala, in fimo bovino, 20. August 1878. Karst. 3762. (H).

ORIGINAL DIAGNOSIS: *Pileus tenerrimus, ex ellipsoideo vel ovoideo expansus revolutusque, sulcatus, glaber, ochreo-isabellinus vel subgilvus, expallens, demum dilute fuliginatus, ad 1 cm. usque latus. Stipes aequalis, sursum leviter striatulus, primitus puberulus, 1–2 cm. longus. Lamellae fuscae. Sporae angulato-ovoideae, subinde anguloso-sphaeroideae vel sphaeroideo-ellipsoideae, fuscae (s. l.), pellucidae, longit. 13–15 mm., crassit. 8–12 mm. In fimo bovino prope Mustiala die 20 m. Aug. h. a. semel. Priori proximus. Solitarius.*

OBSERVATIONS ON THE TYPE—The type material obtained on loan was in poor condition. The only character that we succeeded in observing in detail was the basidiospores.

BASIDIOSPORES [20,1,1] $13\text{--}15.3 \times 11\text{--}12.8 \times 9.2\text{--}11 \mu\text{m}$, on average $14.44 \times 11.83 \times 9.72 \mu\text{m}$, $Q_1 = 1.16\text{--}1.27$, $Q_2 = 1.46\text{--}1.68$ strongly lentiform, in the frontal view typically rectangular or rounded triangular with or without median constriction, more rarely ovoid, in the lateral view ellipsoid, mostly immature, with large, $2\text{--}2.3 \mu\text{m}$ wide, eccentric germ-pore, subopaque, very dark reddish brown, smooth, with a moderately thick wall; BASIDIA mainly collapsed, four-spored, clavate; PLEUROCYSTIDIA and CHEILOCYSTIDIA collapsed; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—This collection is typical of the taxon it represents. The large, $13\text{--}15 \mu\text{m}$ long, rounded triangular spores are characteristic of this species, as is its habit on dung. The species was long considered obligately coprophilous (Bender

FIG. 30. Spores from the type of *C. schroeteri*.

& Enderle 1988, Orton 1972, Orton & Watling 1979). We examined over 60 collections (Nagy, unpublished) and found that it grows more often on soil than on dung. Generally, the taxa of the genus *Parasola* are more or less ubiquitous in terms of the habitat, except for *P. misera*, the only obligately coprophilous species in this group (Uljé 2005).

Coprinus setulosus Berk. & Broome, Journal of the Linnean Society, Botany 11: 561 (1871). FIGS. 31–33.

LECTOTYPE: Sri Lanka: Peradeniya, habitat and date not given, Thwaites 936. (K) (Pelger 1968: 511) SYNTYPE: same locality, Thwaites 845. (K)

ORIGINAL DIAGNOSIS: *Pileo cylindrico campanulato obtuso usque ad discum striato setis fulvis undique obsito; stipite fistulosus candido sursum attenuato; lamellis angustissimus adnexis.* (N° 845, cum icone, N° 936).

Hab. in vegetabilibus emortuis, Peradeniya Ceylon (Thwaites)–Pileus 10 mm. altus, basi 4 mm. latus; stipes 2.5 cm. longus, medio 1 mm. crassus; lamellae adscendentes, non perfecte evoluta in speciminibus, in quibus candidae sunt sporisque carentes.

OBSERVATIONS ON THE TYPE—The holotype contains 2 partly decayed fruiting bodies (1 old, 1 young) stuck on paper cards.

BASIDIOSPORES [21,1,1] $8.8\text{--}10.4 \times 7.4\text{--}8.9 \times 5.3\text{--}6.7 \mu\text{m}$, on average $9.69 \times 8.12 \times 6.06 \mu\text{m}$, $Q_1 = 1.12\text{--}1.36$, $Q_2 = 1.40\text{--}1.88$, strongly lentiform, in the frontal view subglobose-broadly ovoid, often minutely subhexagonal or triangular, in the lateral view ellipsoid to subamygdaliform, with a prominent hilum, a central germ-pore, $1.7\text{--}1.9 \mu\text{m}$ wide, color dark reddish brown, smooth, with a moderately thick wall; BASIDIA not seen; CHEILOCYSTIDIA mainly collapsed, only a single complete cystidium was found, which was utriform; PLEUROCYSTIDIA collapsed, probably subcylindrical-oblong; PILEIPELLIS hymeniform, with long, lancet-like sclerocystidia (hairs), with brown, thick walls and an obtuse apex (as compared to *P. auricoma*), $150\text{--}310 \times 10\text{--}16 \mu\text{m}$, walls up to $3.5 \mu\text{m}$ thick; VEIL and CAULOCYSTIDIA not found.

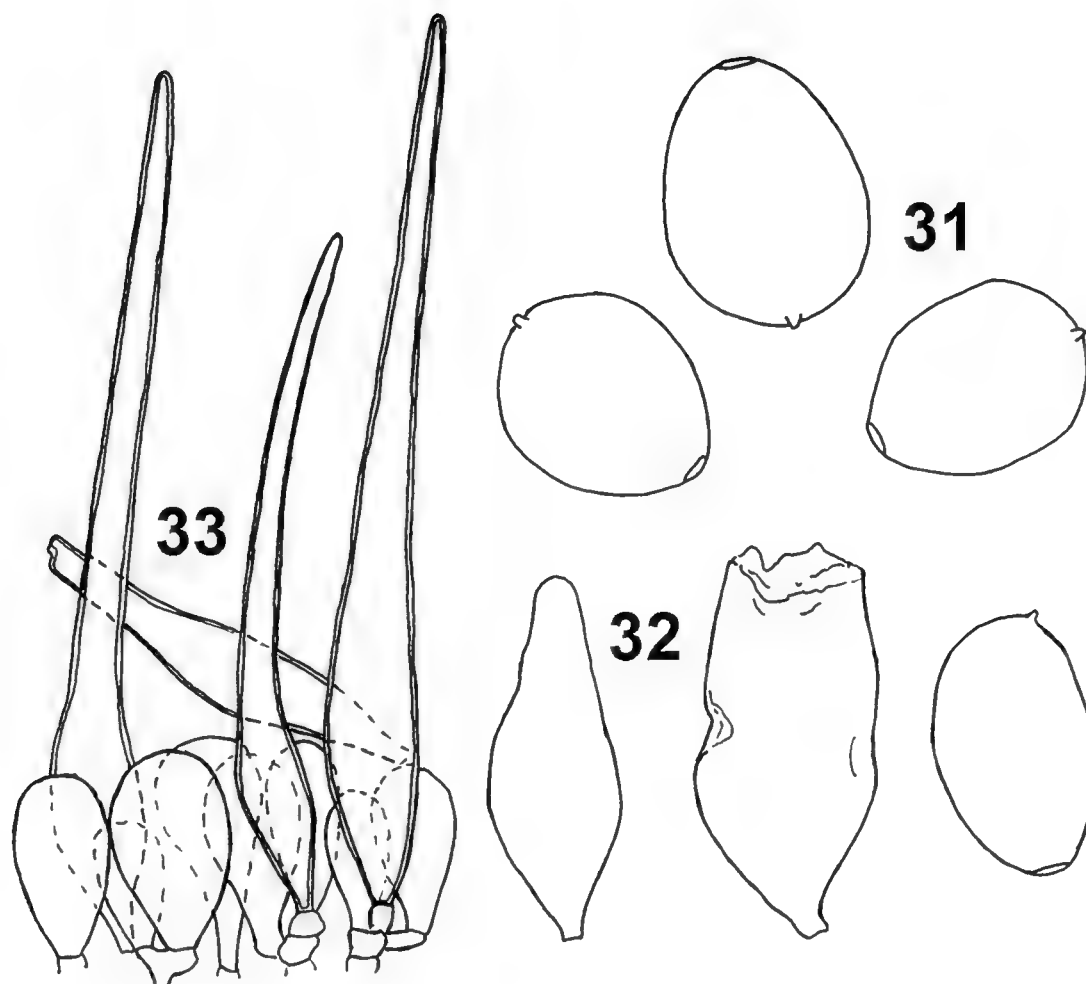


FIG. 31–33. Type material of *C. setulosus*.
Spores (31), partial cystidia (32), and sclerocystidia (33) could be observed.

REMARKS—This is a good species in its own right, but, unfortunately, we know of no recent records. The only specimen reported as *C. setulosus* (WU 14796, leg.: A. Hausknecht, in herb.) is from La Réunion, but this represents a hitherto unclarified *Parasola* taxon with completely elliptical, 7–10 μ m long basidiospores that may well represent an undescribed species.

Pseudocoprinus besseyi A.H. Sm., in Smith & Hesler, Journal of the Elisha Mitchell Scientific Society 62: 189 (1946). FIGS. 34–36.

HOLOTYPE: USA: Michigan, East Lansing, 27. September 1945, E.A. Bessey (MICH).

ORIGINAL DIAGNOSIS: *Pileus* 1–2.5 cm. altus, 15–20 mm. crassus, conicus, subviscidus, glaber, demum convexus et udus, levis demum plicato-striatus, castaneus demum incarnato-cinnamomeus; lamellae confertae demum subdistantes, adnatae, angustae; stipes (3)5–8(9) cm. longus, 3–4.5 mm. crassus, aequalis, subalbidus, glaber; sporae 12–15(16) \times 7–7.5 \times 8–8.5 μ ; pleurocystidia 100–160 \times 20–30 μ , subventricosa, obtusa; cheilocystidia vesiculosa vel ventricosa, 16–25 \times 10–18 μ vel 28–42 \times 12–16 μ .

Habit, habitat and distribution: Scattered to gregarious around and on plant debris, in compost heaps, buried wood, sticks and on lawns but then usually from buried debris.

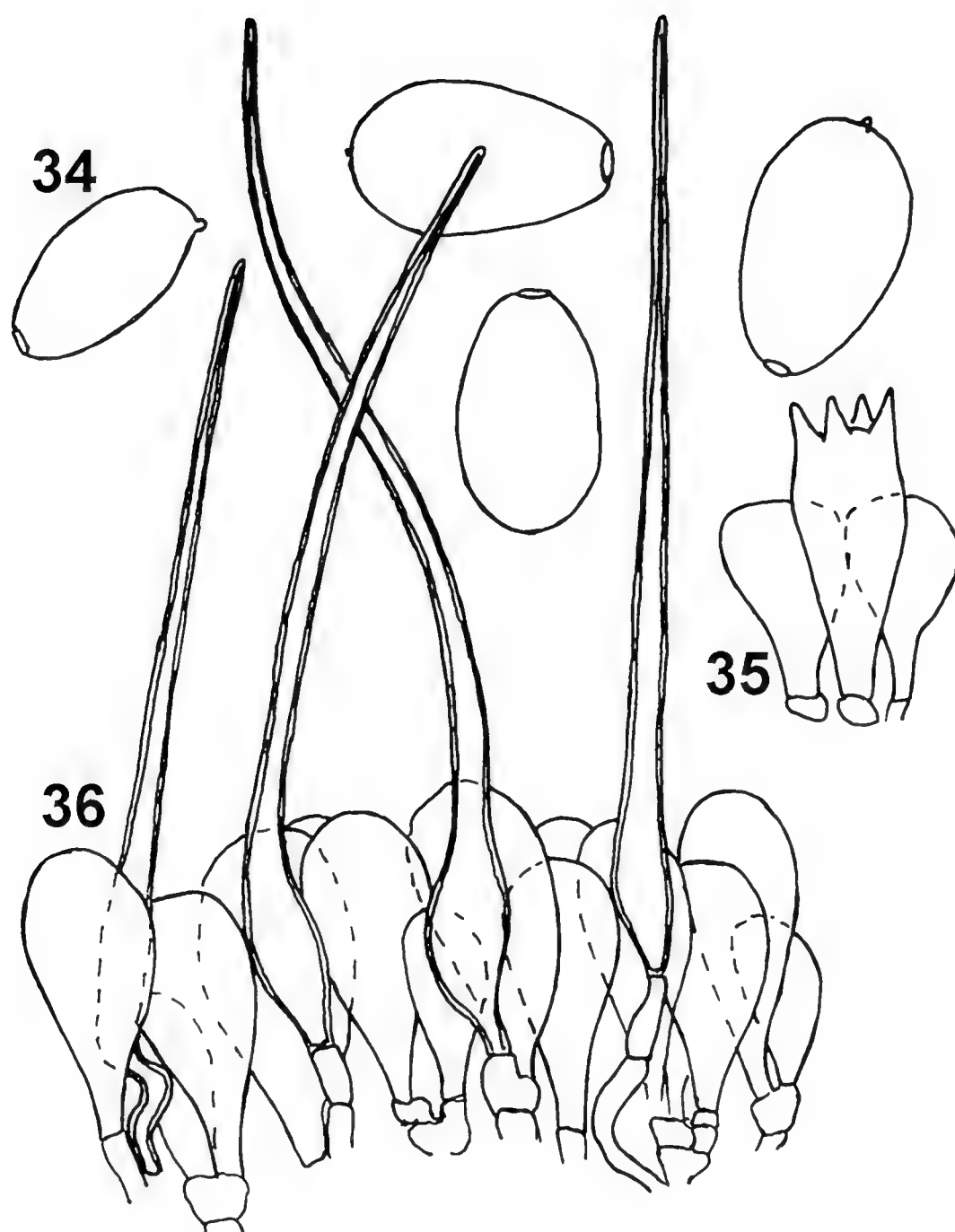


FIG. 34–36. Spores (34), basidia (35), and sclerocystidia (36) from the type material of *Pseudocoprinus besseyi*.

OBSERVATIONS ON THE TYPE—Only part of the holotype was obtained on loan. This contained fragments of probably artificially matured fruiting bodies, in which most cells were collapsed.

BASIDIOSPORES [20,1,1] $13\text{--}15 \times 8\text{--}8.9 \times 7.5\text{ }\mu\text{m}$, on average $13.79 \times 8.44\text{ }\mu\text{m}$, $Q_1 = 1.51\text{--}1.74$, $Q_2 \approx 1.8$ strongly lentiform, in the frontal view oblong to subcylindrical, not flattened, with a $1.5\text{--}1.8\text{ }\mu\text{m}$ wide central germ-pore, color red-brown, smooth, with a moderately thick wall; BASIDIA four-spored, clavate, bimorphic, mainly collapsed; PLEUROCYSTIDIA and CHEILOCYSTIDIA collapsed;

PILEIPELLIS hymeniform, with numerous brown thick-walled erect hairs, up to 250 μm in length; VEIL and CAULOCYSTIDIA not found.

REMARKS—These specimens clearly belong to *P. auricoma*, a well-known, widespread representative of the genus, on account of the ellipsoid spores with a central germ-pore and thick-walled hairs on the pileus. As the epithet *auricomus* dates back to 1886, it has priority over *Ps. besseyi*. Although the basidiospores are on average somewhat larger than usual in *P. auricoma*, we have confirmed that this specimen represents a younger synonym for *P. auricoma*.

Pseudocoprinus lacteus A.H. Sm., in Smith & Hesler, Journal of the Elisha Mitchell Scientific Society 62: 191. (1946). FIGS. 37–39.

HOLOTYPE: USA: Michigan, Ann Arbor, Sept. 12., 1945, A.H. Smith 20520-type. (MICH).

ORIGINAL DIAGNOSIS: *Pileus* 10–15 mm. *altus*, 8–10 mm. *latus*, *conicus*, *glaber*, *plicatostriatus*, *ad discum levis*, *lacteus* vel „pinkish buff” (*pallide argillaceus*), *demum lividus*; *lamellae adnatae, confertae, angustae, lacteae demum fuscae*; *stipes* 3–5 cm. *longus* 1mm. *crassus, aequalis, glaber, fragilissimus*; *sporae* 8.4–10.5 \times 5–6.3 \times 7–8.4 μ ; *cheilocystidia distinctissima*, 22–36 \times (8)10–16 μ .

Habit, habitat and distribution: Gregarious to scattered on bare soil in an oak woods.

OBSERVATIONS ON THE TYPE—Only a part of the holotype was obtained on loan. This contained portions of well-preserved, mainly mature fruiting bodies with a striking whitish pileus. Of the taxonomically important characters, we succeeded in observing basidiospores, basidia, and pleurocystidia.

BASIDIOSPORES [20,1,1] 9.2–11 \times 8.2–9.2 \times 5.8–6.3 μm , on average 9.99 \times 8.61 \times 6.12 μm , $Q_1 = 1.09$ –1.23, $Q_2 = 1.47$ –1.66, strongly lentiform, in the frontal view mostly rounded triangular, some ovoid or subglobose present as well, in the lateral view ellipsoid, germ-pore eccentric, 1.5–1.7 μm in diameter, color dark reddish brown, more or less translucent, but this may be because many immature spores were found, smooth, with a moderately thick wall; BASIDIA four-spored (only incomplete, collapsed basidia were found), clavate; PLEUROCYSTIDIA broadly cylindrical or ellipsoid, ca. 67 \times 30 μm ; CHEILOCYSTIDIA collapsed; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA not found.

REMARKS—To judge from the above description, this species represents a synonym of the taxon currently known as *P. leiocephala*. As the name *Ps. lacteus* (1946) is older than *C. leiocephalus* (1969) and is validly published, it has priority over the epithet *leiocephalus*. The affinity of *Ps. lacteus* to *P. leiocephala* has already been suggested by Uljé et Bas (1988).

The whitish pileus is somewhat unusual for this species, as in most cases the pileus color is some shade of ochraceous or pale-brownish. Such whitish, faded collections can exceptionally be encountered in dry weather (e.g. SZMC-

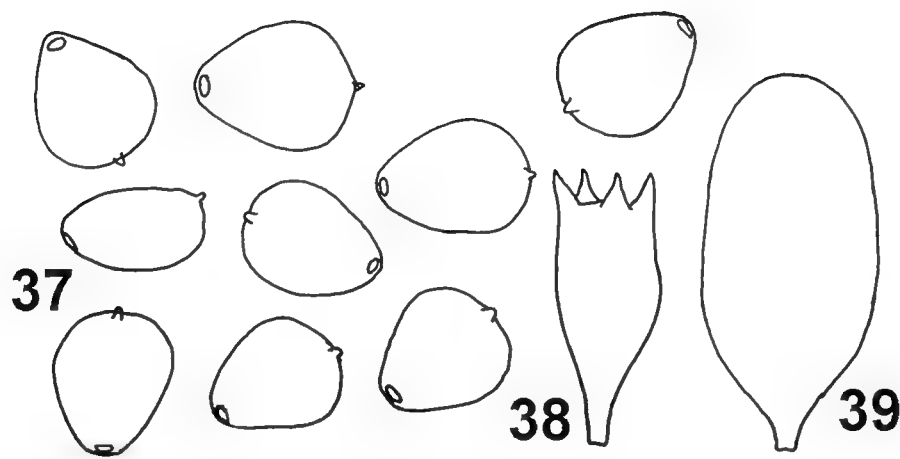


FIG. 37–39. Type material of *Pseudocoprinus lacteus*.
Spores (37), basidium (38), and pleurocystidium (39).

NL-0669 in our herbarium), but no taxonomic value can be assigned to them. In our opinion, both the holotype of *Ps. lacteus* and our collection represent extremities of the species currently known under the name *P. leiocephala* and therefore deserve no taxonomic status.

Nomenclatural revisions

Agaricus plicatilis Curtis, *Flora Londinensis* 1: tab. 215 [engraved no. 200]. (1781)

ORIGINAL DIAGNOSIS: Stalks single, in those which are full grown two inches of more in height, the size of a small wheat straw, upright, round, of the same thickness throughout, hollow, smooth, white, and tender.

Cap at first springs up is about size of a kernel of a hazel nut, of a yellowish brown color, scarce perceptibly striated, it soon becomes an oblong bell-shaped, the small furrows appear more evidently, are somewhat waved, and the color changes to grey or mouse color, now full grown it becomes more bell-shaped, and afterwards appears flat, is from an inch to an inch and half in diameter, of a mouse color, tender, pleated, the crown, flat, brown or white; the skin transparent, without any flash, at top not sprinkled with meal, of the ridges of the plaits somewhat willous, with the fructification is over, the edge becomes black and turns in.

Gills few, of the same color as the cap, throwing out a very fine powder of a bluish-black color.

Its usual place of growth is in pastures, meadows and grass plats, in all of which it is not infrequent during the months of September and October.

REMARKS—Although the protologue is quite obscure and may apply to any *Parasola* taxon, there is consensus about the interpretation and usage of the name *C. plicatilis* in recent literature (Uljé & Bas 1988, Uljé & Bender 1997, Uljé 2005). As Art 8.1 of the Botanical Code allows illustrations to serve as types, we hereby designate as lectotype:

LECTOTYPE HERE DESIGNATED: W. Curtis (1781), *Flora Londinensis* 1: tab. 215 [engraved no. 200].

Additionally, it seems necessary to designate an epitype in order to stabilize the taxonomy of this name and to give a thorough, modern description of the specimen:

EPITYPE HERE DESIGNATED: Hungary, Bács-Kiskun: Kecskemét, Nyír, *Convallario-Quercetum roboris* on sandy soil, 3 September 2006., L. Nagy, SZMC-NL0075 (BP). FIGS. 40–43.

DESCRIPTION—**PILEUS** 5–10 × 8–20 mm when still closed, cylindrical, ellipsoid or obovoid, expanding to convex–hemispherical, finally applanate with a slightly enrolled margin and a markedly depressed disc, surface glabrous, radially translucently striate when young, on expanding becomes radially sulcate–grooved, up to 35 mm in diameter when fully expanded; margin even when young, soon becoming crenulate, color varying from melleous to pale-brown when young, becoming warm fawn on the ridges when mature, between ridges whitish, at centre with +/- sharply delimited darker button, on aging gradually becoming grayish-tinted, not discoloring; **LAMELLAE** crowded, thin, free, not reaching stipe, ending up in a collarium-like formation, up to 2 mm broad, not or only very slightly ventricose, edge fimbriate in young stages, white when young, later greyish, finally blackish, different parts of the gills do not mature in parallel, not deliquescent, only collapsing when fully mature; **STIPE** 0.5–3 × 30–70 mm, slender, fragile, fistulose, cylindrical, at base with scanty whitish tomentum, surface glabrous or finely longitudinally silky, whitish all over when young, on aging becoming pale-ochraceous; **CONTEXT** thin and brittle, whitish, without a distinct smell or taste.

BASIDIOSPORES [20,1,1] 10.8–14.2 × 7.8–8.5 × 6.8–7.5 µm, on average 12.41 × 8.21 × 7.14 µm, $Q_1 = 1.34$ –1.67, $Q_2 = 1.61$ –1.86, strongly lentiform, in the frontal view chiefly limoniform–subhexagonal, more rarely ovoid, broadly ellipsoid, in the lateral view ellipsoid to subamygdaliform, with an eccentric, 1.9–2.3 µm wide germ-pore, color very dark reddish brown, opaque, smooth, with a moderately thick wall; **BASIDIA** clavate, most with median constriction, bimorphic, 23–34 × 10–12 µm; **CHEILOCYSTIDIA** densely packed, mainly utriform, cylindrical, oblong, rarely clavate–globose, 40–60 × 13–27 µm; **PLEUROCYSTIDIA** mainly broadly utriform, oblong or subcylindrical, often obovoid, rather abundant; **PILEIPELLIS** hymeniform, glabrous; **VEIL**, **PILEOCYSTIDIA**, and **CAULOCYSTIDIA** absent; **CLAMPS** present.

Nuclear ribosomal ITS and LSU sequences have shown that the epitype collection is nested within the clade formed by other specimens of *P. plicatilis*. These sequences clustered together with other materials of *P. plicatilis*, forming a well-supported lineage (BPP: 1.00, ML and MP bootstrap: 100%) (Nagy et al. 2009). In this case it was important to test the position of the epitype specimens, because unpublished sequence data suggest the existence of another species related to *P. plicatilis*. Typical specimens of this hitherto undescribed taxon

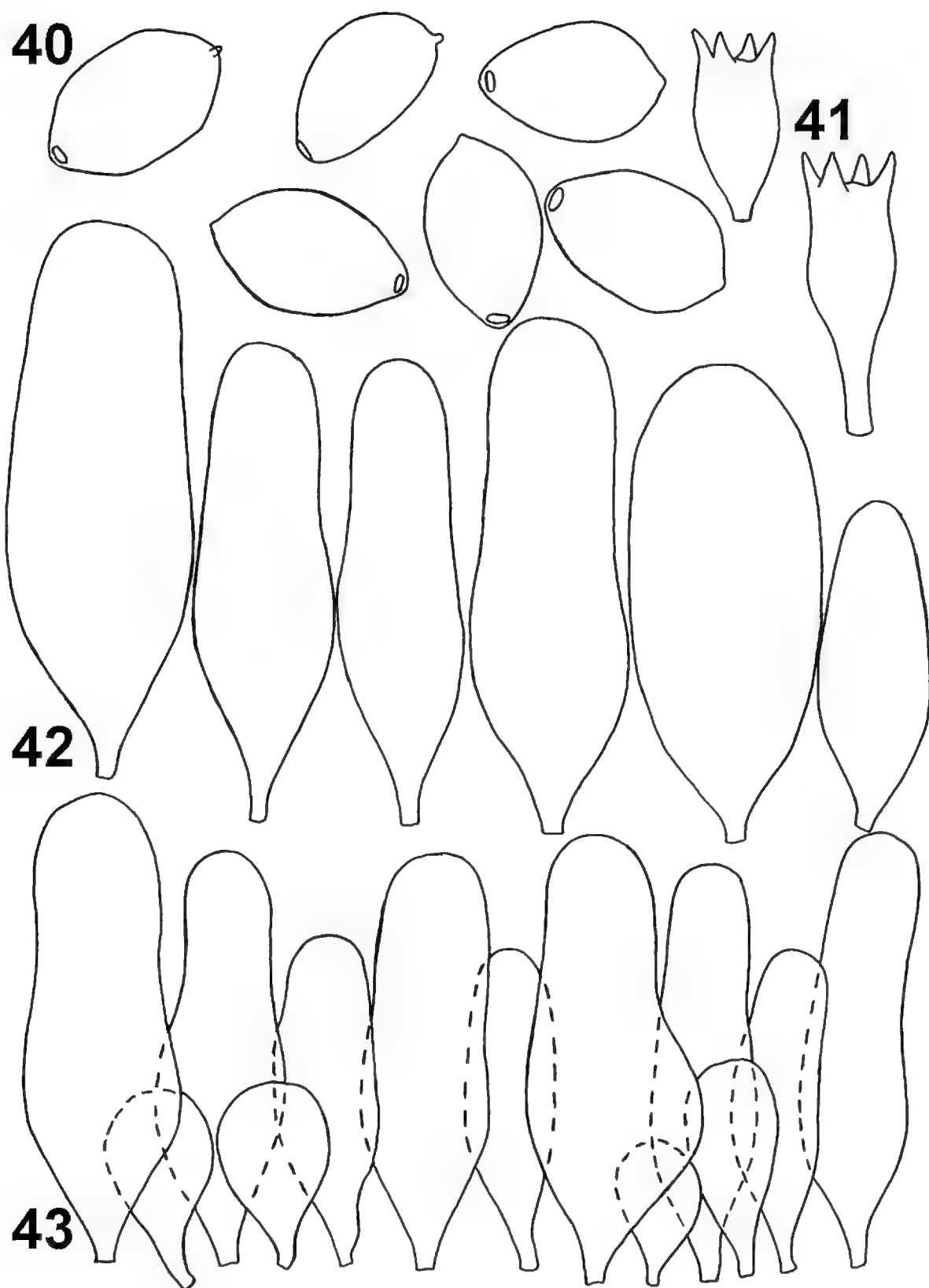


FIG. 40–43. Epitype of *Parasola plicatilis*.
Spores (40), basidia (41), pleuro- (42), and cheilocystidia (43) are depicted.

have a lilaceous stipe, and a slightly darker-brown pileus than *P. plicatilis*. As in *P. lilatincta*, it is often difficult to recognize the lilaceous colouration of the stipes.

Further, in dried specimens, the lilac colouration fades to a dark ochraceous tint, making identification of dry materials difficult.

Agaricus subtilis Fr., *Systema Mycologicum* 1: 302. (1821).

ORIGINAL DIAGNOSIS: *pileo submembranaceo campanulato levi albido, lamellis adnatis nigris, margine albis, stipite glabro albo. Tenellus. Stipes ½ unc. Longus, filiformis, nudus, laevis, fragilis. Pileus 3 lin. altus & latus, obtusus, leavis. Lamellae latiusculae, adscendentes, cinereo-nigricantes. In fimo locis udis silvaticis. Sept. Oct.*

REMARKS—Some authors consider this taxon a synonym of *P. misera* (e.g. Jossierand 1962) or *P. schroeteri* (Bender & Enderle 1988). Although the original diagnosis allows such an interpretation, many important details are missing from the description, and we prefer therefore not to assign this name to *P. schroeteri*. Orton & Watling (1979: 10) came to the same conclusion.

Coprinus auricomus Pat., *Tabulae Analyticae Fungorum* 1(5): 200. (1886).

ORIGINAL DIAGNOSIS: Chapeau ovoïde puis campanulé, membraneux, glabre sur la disque, pruineux (à la loupe) sur le restant, cendré-roux avec le sommet brun-rougeâtre, finement strié. Lames étroites, serrées, roussâtres-noires; cystides cylindriques; spores ocracées-brunes. Stipe creux, grêle, blanc, fragile, glabre.

La jeune est d'abord enveloppée par un ozonium doré, dont il reste parfois des filaments sur le chapeau adulte et à la base du pied. L'aspect cendré pruineux du chapeau est dû aux cellules épidermiques incolores placées sur un tissu roussâtre.

Cespiteux sur les vieilles souches. Été. Bois de Vincennes.

REMARKS—We did not succeed in locating any specimen as type. However, Table 453 of Patouillard (1886: 200) can serve as type, and accordingly we hereby designate this as lectotype:

LECTOTYPE HERE DESIGNATED: N.T. Patouillard (1886) *Tabulae Analyticae Fungorum* 1(5): tab. 453. 1886.

The original description is sufficiently diagnostic for a clear-cut definition of this taxon.

The structure interpreted as ozonium by Patouillard may in fact represent abundant thick-walled hairs at the base of the stipe. This is often visible on young fruiting bodies, but vanishes during development of the stipe. We have not observed true ozonium in any species of *Parasola* to date.

Coprinus elongatipes A.H. Sm. & Hesler, *Journal of the Elisha Mitchell Scientific Society* 62: 180 (1946).

ORIGINAL DIAGNOSIS: *Pileus 2–5 cm. latus, conicus vel convexus, udus, glaber, hygrophanus, cinnamomeo-brunneus dein fulvus vel avellaneus, cum sicco atomatus, non plicatus; lamellae ferrugineo-brunneae, perangustae, confertae, adnatae, margine albo-fimbriatae; stipes 6–10 cm. longus 2–3 mm. crassus, fragilis, aequalis, sursum pruinosis, deorsum glaber; ozonium fulvum; sporae 10–12.5 × 6.5–8 µ, ellipsoideae vel subovoideae.*

Habit, habitat and distribution: Among grass and weeds on soil in open deciduous

woods, Estes Park, Rocky Mountain National Park, 8500 ft. elev., July 10, 1940, L.R. Hesler 12689-type

REMARKS—The type specimen in TENN is thought to be missing. It has been suggested (Patricia Rogers, pers. comm.) that it may have been transferred to MICH, but we did not succeed in finding it there.

Despite the lack of type we consider that this species is synonymous with *P. auricoma*, which is supported by the original description. Although not mentioned in the protologue, Smith & Hesler (1946: 181, FIG. 1E) depict the characteristic thick-walled hairs on the pileus, characteristic of *P. auricoma*.

Coprinus hansenii J.E. Lange, Dansk Botanisk Arkiv 2(3): 48 (1915).

ORIGINAL DIAGNOSIS: Spores oval-ovate, $12\text{--}13 \times 7 \mu$, dark grayish-brown, slightly pellucid. Basidia 9–10 diam.; paraphyses 17–18 μ . Cystidia vesiculous, somewhat bottle-shaped, with a short or rather long neck about 20 μ broad. The surface of the cap is formed by balloon-shaped or almost pyriform cells (16–24 μ broad).

FIG. Specim.: Hunderup, on the ground near a dead stump of *Populus*, June 1902.—Also Horsens, 1908, and Lundeborg, Aug. 1914, on naked ground behind a garden-hedge.

Cap at first oval-cylindric, 1¼–2 cm high, dark rufous chestnut-brown (apex darker), naked, striate, then expanded, at last flat, fisso-sulcate 2/3 way up (disc flat or slightly depressed), 3–4.5 cm across, of a lighter and paler brownish color than the bud. Stem rather tough, whitish (tinted slightly brownish), inside subochraceous, fistulose, glabrous, top somewhat striate, 7–9 cm \times 3–4 mm. Gills free, narrow, at first pale, then ochraceous-brown, at last black, hardly diffluent. Subfasciculate.

Having found no description anywhere of this characteristic species I have named it after Hansenii in commemoration of the Danish biologist and mycologist Emil Chr. Hansen, author of *Fungi fimicoli Danici*.

REMARKS—Although Lange (1915, 1935) describes the pileus as devoid of hairs, we acknowledge the widely accepted synonymy of *C. hansenii* with *P. auricoma* (Breitenbech & Kränzlin 1995, Uljé & Bas 1988, Uljé 2005). Orton & Watling (1979) disagreed upon the synonymy of *C. hansenii* with *P. auricoma*, suggesting that Lange's species may be a forgotten taxon needing rediscovery. However, as all other details of the original description as well as the figures given by Lange agree with those of *P. auricoma*, and we have been unable to find any specimen that would fit the description, for the time being we prefer to treat *C. hansenii* as a synonym of *P. auricoma*.

Coprinus hemerobius Fr., *Epicrisis Systematis Mycologici*: 253 (1838).

ORIGINAL DIAGNOSIS: *Pileo tenerrimo ovato laeviusculo, expanso campanulato fisso sulcato glabro, vertice subprominente, stipite elongato attenuato glabro pallido, lamellis linearibus e pallido-nigricantibus collario obsoleto adnexis*. A. campan. Bolt. 31. Pollich. Pal. 3. p. 295. Cfr. Secr. N. 428. Juxta vias. Habitus omnino praeced. Sed stipes collarium vix manifestum, lam. 1–1.5 lin. latae. Notis discerni nequit A. bubalinus Schum. (Fl. Dan. T. 1960. f. 2.) a statu primario, pileo nondum fisso.

REMARKS—The identity of this taxon has long been disputed (Orton & Watling 1979, Orton 1972, Uljé & Bas 1988). Most commonly, the epithet *hemerobius* has been applied to *P. auricoma* and *P. plicatilis* (Kühner & Josserand 1934, Lange 1935, Uljé & Bas 1988), but since no type material exists, we consider it a name to be rejected.

In the literature, this name is often used to refer to a species with elliptical basidiospores and glabrous pileus (i.e. no hairs on the pileipellis) (Orton 1972, Orton & Watling 1979). Orton & Watling (1979) distinguished this species from *P. plicatilis* in view of its not or only slightly lentiform spores and incompletely expanding pileus. In our experience, the spore shape can vary considerably, but we have never observed completely non-lentiform spores during our studies on *Parasola* (Nagy, unpublished). It has also been argued that, in fact, this species does not exist (Uljé & Bas 1988). In course of our examinations of hundreds of *Parasola* collections, we have come across a few specimens with such a combination of features (ellipsoid spores, and no hairs on the pileus), but careful examination of these specimens always revealed some tendency of the basidiospores to be hexagonal or ovoid and lentiform. Hence, in our opinion, the above-mentioned interpretation of *C. hemerobius* refers to +/- aberrant collections of *P. plicatilis*. Due to the dubious usage of the epithet *hemerobius*, we continue to use *P. plicatilis* for these collections.

Coprinus longipes Buller, in Bisby et al., Fungi of Manitoba: 118 (1929).

ORIGINAL DESCRIPTION: pileus 6–10 mm. high before expansion, bay-brown, darker at the obtuse apex, at first conico-campanulate, on expanding becoming broadly convex but never becoming flattened or revolute, thus resembling the pileus of *C. plicatilis*; when fully expanded 13–23 mm. broad, usually 15–18 mm.; the disc 3–4 mm. wide, reddish brown and markedly depressed; the convex sides of the pileus grayish brown and beautifully plicate, the surface of the pileus lacking both hairs and scales. Stipe sometimes only 4–5 cm. long, but usually 6–11 cm., occasionally up to 15 cm. long, evenly cylindrical, 1–1.5 mm. in diameter except at the base where it is 2 mm., straight, somewhat brownish below, white above, smooth, hollow, somewhat stiff. Gills grayish, narrow, 1–1.5 mm. wide, free and attached to a collar below the disc, autodigestion occurring to some extent along the edges. Flesh very thin, brownish at the disc. Spores black in mass, jet-black under the microscope, smooth, rounded heart-shapes with three differing dimensions, $14\text{--}15.5 \times 12\text{--}13 \times 10 \mu$. Basidia dimorphic, each surrounded by 5–8 paraphyses. Cystidia on the sides of the gills, ovoid-tapering, sometimes capitate, fairly numerous in the young pilei but disappearing by deliquescence during spore discharge. Observed on a number of occasions in laboratory horse-dung cultures, coming up after several weeks or month.

This species resembles *C. plicatilis* in general appearance and might be mistaken for it; but it differs in coming up on horse dung instead of in grassy places, in having a slightly smaller depressed disc, in having gills which waste or deliquesce at their edges instead of remaining entire, and having a stipe which is usually longer.

REMARKS—In our opinion, the above description fits very well with *P. schroeteri*. All the diagnostic features are given by Buller: plicate, glabrous pileus, flattened spores with length between 13 and 15 μm , no deliquescence, habitat on dung and resemblance to *C. plicatilis*, and we feel that it is sufficient enough to synonymize it with *P. schroeteri*. This is in contrast with the opinion of earlier authors (Bender & Enderle 1988, Uljé & Bas 1988), who preferred to consider it a nomen dubium. They came to this conclusion because, when tracing the type, only spore prints were received (not made by Buller himself), which they assigned to *C. marculentus*, a totally different species. However, we see no evidence that the spore prints and the type of *C. longipes* have anything in common. Furthermore, the original diagnosis (as far as it can be trusted) excludes *C. marculentus* by stating: “the surface of the pileus lacking both hairs and scales”.

Similar to Uljé & Bas (1988), we could not locate the type.

Considerably after the publication of this name, Buller (1958: FIGS. 35–39) reported photographs of *C. longipes*, depicting a typical *Parasola*-like fungus. The photographs were taken from laboratory cultures, which may explain the unusual length of stipes (for instance, when cultured in flasks). Unfortunately, the photographs are not accompanied by collection numbers or dates, so they are not suitable for typification.

Coprinus mirabilis Mont., Annales des Sciences Naturelles, Botanique, 4e Sér., 1: 106 (1854).

ORIGINAL DIAGNOSIS: *Pileo tenerrimo primitus... tandem explanato sulcato albo margine crenulato, stipite gracili fistuloso concolori, lamellis distantibus convexis tandem nigris, sporis globosis.*—*Hab. In herbidis ambulacri urbis Cayennae. Coll. 1059.*

REMARKS—The only clue that suggests a *Parasola* species in the protologue is the globose spores. Otherwise, it is very unclear and may apply to numerous *Coprinus* s.l. species. We could not trace any type material. Pegler (1983) presented specimens and a description of a mushroom with affinities to *P. auricoma*, but differing in lenticular spores. However, it was not detailed how this species relates to the original description and what the author's concept is based on. As presented by Pegler (1983), *P. mirabilis* may be similar if not identical with *P. setulosa* (see above).

Coprinus miser P. Karst., Bidrag till Kännedom af Finlands Natur och Folk 37: 236 (1882).

ORIGINAL DIAGNOSIS: Glasklar, m. späd, bar ljust askgrå; hatten veckad; lamellerna glesa, få (6–15), slutl. Af sporerna svarta; sporerna pyramidförmigt äggrunda eller elliptiska. Hästexkr. 9. finl. (Mustiala).

REMARKS—We could not trace any type material in H. However, as there is consensus concerning the usage of this name, we hereby designate a neotype, nested in the *P. misera* clade by ITS and LSU sequences (Nagy et al. 2009):

NEOTYPE here designated: Hungary, Heves: Bükk mts., Cserépfalu, Bogár-hegy, on cow dung, in grazed, calcareous mountainous grassland, 12 March 2007, L. Nagy, SZMC-NL-0280 (BP). FIGS. 44–47.

DESCRIPTION OF THE NEOTYPE—PILEUS 3–6 × 1–4 mm when closed, ellipsoid, obovoid, rarely subglobose, expanding to obtusely conical or campanulate, convex-hemispherical when older, applanate or plano-concave when fully mature, up to 15 mm in diameter; margin straight, translucently striate up to 2/3rd of pileus, even when young, later becoming undulate-crenate as the pileus expands, surface glabrous, smooth at disc, slightly rugulose-grooved when young, upon expanding becomes sulcate-plicate; color warm melleous, apricot colored, darker towards disc, becoming greyish on aging; LAMELLAE crowded, free, forming a delicate collarium-like structure around stipe, up to 1.5 mm broad, strongly ventricose, edge fimbriate, whitish, color whitish when young, gradually becoming grayish to blackish, maturation takes place in patches, not deliquescent; STIPE 0.3–1 × 10–25 mm, cylindrical, often with a somewhat swollen base, fistulose, very fragile, minutely silky-fibrillose when young, later glabrous-silky, whitish to pale ochraceous when old; CONTEXT very thin, fragile, without peculiar smell or taste.

BASIDIOSPORES [20,1,1] 8.5–10.6 × 8.5–10 × 5.9–6.6 µm, on average 9.45 × 9.05 × 6.21 µm, $Q_1 = 0.96$ –1.12, $Q_2 = 1.43$ –1.61, strongly lentiform, in the frontal view subglobose, rounded triangular or heart-shaped, more rarely ovoid, apex sometimes papillate, in the lateral view ellipsoid, with a 1.5–1.7 µm wide, strongly eccentric germ-pore, color very dark reddish brown, opaque, smooth, with moderately thick wall; BASIDIA bimorphic, clavate, often with median constriction, four-spored, 25–35 × 9–10 µm; CHEILOCYSTIDIA clavate, vesiculose or globose, abundant, 20–25 × 13–17 µm; PLEUROCYSTIDIA absent; PILEIPELLIS hynemiform, made up mainly of vesiculose-globose elements, 22–40 × 21–25 µm; VEIL, PILEOCYSTIDIA, and CAULOCYSTIDIA absent; CLAMPS present.

Coprinus miser f. *marasmiioides* Romagn., Bull. Soc. Mycol. Fr. 77: 325 (1962, “1961”).

ORIGINAL DIAGNOSIS: *A typo differt pileo truncato et sporis minoribus, 7.7–9.5 × 7–9 × 5.7–6.5 µ.*

REMARKS—Unfortunately, type material could not be obtained from PC. From the size of the basidiospores it may be assumed that this collection belongs to the variant with four-spored basidia (two-spored specimens represent a

phylogenetically distinct taxon; Nagy et al. unpubl.), and we therefore consider this taxon a synonym of *P. misera* var. *misera*.

Coprinus plicatilis* var. *microsporus Kühner & Joss., Bulletin de la Société Mycologique de France 50: 57 (1934).

ORIGINAL DIAGNOSIS: Dans l'herbe ou les feuilles mortes au Bois de Vincennes, mai-juillet. Chapeau (D: 1.5–4 cm) campanulé subglobuleux ou ellipsoïde puis conique obtus surbaissé ou convexe plan, souvent nettement déprimé ombiliqué et à la fin cyathiforme mais parfois aussi non ombiliqué ou même obtusément mammelonné au fond de la dépression centrale, plissé véliforme, brunâtre puis gris, gris jaunâtre diaphane avec le centre gris-jaunâtre, jaune-brun hyalin ou fauvâtre (jaune brun au début).

Revêtement glabre ou micacé sur les côtes.

Lames (L:28–50; l:1) +/- espacées chez l'adulte, ténues diaphanes adnées à un disque bien développé.

Stipe (H:4–7.5 cm; D:1–2 mm) subégel, blanc hyalin (la base parfois un peu hyalin brunâtre) glabre ou un peu soyeux, tubuleux.

Spores brun bistre foncé et opaque s.l. mais pas tout à fait noires, à silhouette ovoïde, ovoïde cinquante, ovoïde rhombique, nettement atténué vers la partie supérieure, à profil elliptique aplani sur la face dorsale: $8.2-10 \times 5.5-7.5 \times 4-5.7 \mu$.

Pore légèrement incliné sur la face ventrale.

Basides tétrasporiques.

Cystides faciales de grande taille.

Revêtement piléique celluleux hyméniforme dépourvu de poils; voile nul.

Ad caules emortuos, et folia putrescentia. Gallia.

REMARKS—This taxon is currently known as *P. kuehneri* (Uljé & Bas 1988). It is characterized by small spores with a tendency to be rhomboid or quadrangular. Other differences, such as a brighter color of the pileus and more cylindrical cheilocystidia (Uljé & Bas 1988, Uljé & Bender 1997), are, in our experience, not sufficiently constant to be considered diagnostic for identification.

Coprinus plicatilis* var. *tenellus Rick, Broteria 5: 20 (1906), as “*tenella*”.

ORIGINAL DIAGNOSIS: *Ad terram. Firmior et minor quam typus et pede minute pruinoso.*

Similis Coprino filiformi Berk. et Br.

REMARKS—In our opinion, this taxon certainly does not belong to *Parasola* in view of the pruinose stipe and the resemblance to *C. filiformis* (probably a *Coprinopsis*) as mentioned by Rick. Unfortunately, we did not succeed in locating the type.

Coprinus proximellus P. Karst. Meddelanden af Societas pro Fauna et Flora Fennica 5: 34 (1879).

ORIGINAL DIAGNOSIS: *A praecedente praecipue sporis ellipsoideis, fuscis, semipellucidis, 10-13 mmm. longis, 5-7 mmm. crassis recedens. Locis stercoratis in horto Mustialensi mensibus Majo et Augusto parce. Pileus primitus subhirtellus et pallide subgilvus. Solitarius.*

REMARKS—We could not locate the type material, and the original description is quite obsolete. To judge from the spore size it could be either *P. plicatilis* or *P. auricoma*.

Coprinus pseudonycthemerus Britzelm., Hymenomyceten aus Südbayern. IX. Teil: 13, Melanospori f. 250 (1893). [Also published as: Botanisches Centralblatt 54: 70 (1893).]

ORIGINAL DIAGNOSIS: (from Bot. Centralbl. 54: 70): Sp. 14 : 10, unförmlich rundlich mit einem spitzen Ende; H. gefurcht, gelbgrau, grau, Mitte gelblich; L. z. g., angeheftet, grau, schwarz bestäubt, zuletzt schwarz; St. durchscheinend, unt etwas rothbraun, s. gebrechlich; Sommer, Herbst, A.

REMARKS—Uljé & Bas (1988: 444) and Bender & Enderle (1988) pointed out that this species might have affinities to *P. schroeteri*. This is supported by the rounded spores with a size of around $14 \times 10 \mu\text{m}$. Unfortunately, Britzelmayr left types only very scantily, and accordingly tracing of the type of this species is very unlikely.

Coprinus rimosus Copel., Annales Mycologici 3: 26 (1905).

ORIGINAL DIAGNOSIS: *Pileo tenui, cylindrico-campanulato vel conico, truncato, 1.5–2 cm alto et lato, glabro, pseudo-plicato, in lamellis moi deorsum fisso, externe fulvo-griseo, in rimis nigrescente, discus fulvo, plano vel depresso; lamellis liberis, modice remotis, stipitem versus excavatis, ad marginem obtusis, nigris pallescentibus, cystidiis carentibus: sporis nigris, typicis subangularibus, $15 \times 13.5 \mu$, apicem versus crassissimis; stipite albo, glabro, aequali, cavo.*

Ad fimum aequinum. Manila.—A Coprino plicatili Fries pileo non explanato, sporis crassioribus et substrato fimi distinguitur.

REMARKS—We consider that the glabrous pileus, the habitat on dung, and the spore size are sufficiently diagnostic for a clear identification of *C. rimosus* as a younger synonym of *P. schroeteri*. This relationship has already been suggested (Uljé & Bas 1988), but no conclusion was drawn awaiting further evidence or type study. The type could not be found at UC, MICH, or WELT.

Coprinus sulphureus McClatchie, Proceedings of the Southern California Academy of Sciences 1: 381 (1897).

ORIGINAL DIAGNOSIS: *Pileo oblongo-campanulato, dein expanso et margine revoluto, griseolo v. luteolo-brunneo, subtiliter striato, villosa, 2–3.5 cm. alto; stipite cavo, sursum attenuato, 5–7.5 cm. longo, medio 3–4 mm. crasso, pilis luteolis tecto; lamellis liberis, linearibus, 8–12 mm. latis, acie sulphureis; sporis ellipticis, $15–18 \times 8$.*

Hab inter folia et ramos dejectos sub arboribus, Pasadena et Compton Californiae (McClatchie).

REMARKS—The above description fits best with *P. auricoma*, although the spores are slightly larger, but the yellowish hairs on the pileus are diagnostic. Unfortunately, no recent description or type study is available for this taxon.

Coprinus virgulacolens Cleland, Transactions of the Royal Society of South Australia 57: 194 (1933).

ORIGINAL DIAGNOSIS: *Pileus* 1.2–2.5 cm., 16 mm. *altus cylindrico-conicus ad lato-conicus, deinde se expandens, membranaceus, disco glabro subconvexo fusco, striatoplicatus, pallido-furfuraceus-granulosus, cinereo-brunneus. Lamellae subadnexae vel adnatae, primum adscendentes, confertae, angustae, albiae, deinde purpureo-brunneae. Stipes* 3.7–6.2 cm., *granulosus et striatus, deinde glaber, concavus, sub-bulbosus, albus. Caro pertenuis, brunnea. Sporae obliquae, fuscae, 7.5–9 μ , interdum 11 \times 4–5 μ . Plantae in terra virgulis applicatae. S.A.–Mount Lofty.*

REMARKS—Simpson & Grgurinovic (2001) recombined this taxon in *Parasola*, presumably on the basis of a former examination and lectotypification (Grgurinovic 1997). However, both the original description and the observation of Grgurinovic (1997) point away from the genus *Parasola*. The protologue clearly mentions granulosity of the pileus and stipe when young, a feature typical of subsection *Nivei* of *Coprinus s.l.* Unfortunately, no further information can be found in the above-mentioned two descriptions and no type material could be obtained from AD. Therefore, for the time being we feel it premature to draw any conclusion about the identity of this taxon.

Psathyrella subprona Cleland, Transactions of the Royal Society of South Australia 51: 306 (1927).

ORIGINAL DESCRIPTION: *Pileus* ½ in. (1–2 cm.) broad, 3/8 in. (10mm.) high, conico-campanulate with an acute apex, drying an opaque pallid whitish with fine anastomosing striae, greyer when moist. Gills ascending a little, adnate, moderately close, clouded fuscous-grey. Stem 1 to 1 and ½ in. (2.5 to 3.7 cm.) high, slender, slightly mealy, then polished, slightly hollow, somewhat brittle, white. Flesh thin, that of the stem different in texture from the flesh of the pileus. Spores nearly black, elliptical, 15 \times 8 μ .

REMARKS—To judge from the only available modern description (Grgurinovic 1997: 475), this species may be closely related or even conspecific with the taxon currently known as *P. megasperma*. Grgurinovic (1997) reported the germ-pore as central, whereas *P. megasperma* usually has a more or less eccentric germ-pore. Unfortunately, type material could not be obtained from AD. Without study of the type, however, the available evidence is not sufficient to allow change of the widely accepted name *megasperma* to *subprona*.

Pseudocoprinus brunneolus McKnight, in McKnight & Allison, Morris Arboretum Bulletin 20: 73 (1970, “1969”).

ORIGINAL DIAGNOSIS: *Pileus lato-convexus disco subdepresso praeditus, 10–17 mm diam.; discus glaber, modice brunneus, profundo plicato striatus, e disco ad marginem roseo-griseus usque brunneo-roseus; caro tenuis, odore et sapore carentibus.*

Lamellae crassae, dissettae cum lamellulis alternantes, primum albae deinde griseae demum sporis maturis fere atrae, margine acuto et superficiebus convergentibus praeditae, non deliquescentes, in maturitate e stipite separantes.

Stipes cartilagineus, fragilis, 20–50 × 0.5–1.0 mm filiformis, semi translucidus, albus, glaber, bizonatus, cellulis texturae centralis in zona interiori 4–5 μ , in zona corticali 1.3–3.5 μ diam.

Cuticula pilei e palo cellularum piroformium 25–40 × 15–18 μ composita; hypodermium in KOH ochraceum; cheilocystidia e subcylindrico clavata vel ventricosa, tenui-tunicata, fasciculata, 11–15 × 55–60 μ ; pleurocystidia non visa; basidia tetraspora; sporae in KOH sordide cacinae, a latere visea brevi-ellipticae et applanatae, a fronte angulato-ovoideae, distincte apiculatae, uniguttulatae, 9–11.8 × 6.7–7 × 7.9–9.7 μ , poro germinationis distincto lato apicali praeditae.

Hab. ad terram muscosam sub Quercus, Laurel, Maryland. Typus legit O.K. Miller 6919 (BFDL).

REMARKS—The above description fits perfectly with *P. lactea* (= *P. leiocephala*) in all important details, and we therefore consider *Ps. brunneolus* to be a synonym of that species. Unfortunately, we did not succeed in finding the type in BFDL (= CFMR).

Discussion

As might be expected from in-depth nomenclatural revisions of even better known taxa, we found that numerous names neglected in the recent literature have priority over their younger counterparts in every day usage. We were able to study types of 15 taxa formerly recombined or affiliated with *Parasola* or *Coprinus* subsection *Glabri* and *Auricomi*. As a result of the study of the holotype of *Ps. lacteus*, we found that *P. leiocephala* should be substituted by *P. lactea*, which dates back to 1946, as opposed to *Coprinus leiocephalus*, which was described in 1969. This relationship has already been suggested by Uljé & Bas (1988), but they did not study the type, and hence could not come to the proper conclusion.

Coprinus leiocephalus is such a widely accepted and used name that the necessity of a name change raises the possibility of conservation of the epithet *leiocephalus* against *lacteus*. The conservation of a name simply because it is inappropriate or not popular is generally counteradvised, and we think that in this case it is better to adhere to the rules than to initiate a long-lasting decision procedure by the Nomenclatural Committee. Besides *P. leiocephala*, *Ps. brunneolus*, *C. plicatilis* var. *filopes*, and *C. galericuliformis* should be synonymized with *P. lactea*. Of these, *C. galericuliformis* is often accepted as a separate taxon (e.g. Orton & Watling 1979, Roux 2006, Uljé & Bas 1988, Uljé 2005), but no straightforward definition is given by any of the mentioned authors. The only difference constantly cited is the shape of the spores, which is subglobose, whereas *P. lactea* should differ in having more triangular spores (Roux 2006, Uljé & Bas 1988, Uljé & Bender 1997, Uljé 2005). In fact the type of *P. galericuliformis* is composed of immature fruiting bodies, and hence the

shape of the spores is not surprising. Specimens of *P. lactea* with partially subglobose spores can be encountered quite often (Nagy, unpublished, Uljé & Bas 1988). Molecular studies using ITS and LSU sequences have demonstrated that specimens with subglobose spores are identical to *P. lactea* and that phylogenetically only one species can be recognized in this group (Nagy et al. 2009).

We found the following taxa conspecific with *P. auricoma*: *Ps. besseyi*, *C. sulphureus*, *C. hansenii*, *C. elongatipes*. A name change from *P. megasperma* to *P. subprona* will likely be needed in the future, but as we were unable to obtain the type material of *Psathyrella subprona* on loan, at this stage we refrain from formally proposing a name change.

Parasola setulosa is redescribed on the basis of the holotype as a species with brown, thick-walled sclerocystidia on the pileus (similarly to *P. auricoma*) and lentiform spores, a unique combination of characters in the genus *Parasola*. Unfortunately, this species is known only from three type collections. New collections would be helpful in addressing the variability and phylogenetic position of this species. As *P. setulosa* combines morphological features of early-branching *Parasola* taxa (*P. conopila* and *P. auricoma*) with features of other taxa of the genus (which we formerly referred to as “crown” *Parasola* taxa, e.g. *P. plicatilis* and *P. lactea*, see Nagy et al. 2009), we hypothesized it may represent a link between *P. auricoma* and the other collapsing species of *Parasola* (“crown” *Parasola* taxa).

As exemplified above, many names of coprinoid fungi (*Parasola*, *Coprinellus* and *Coprinopsis*) that are out of use today may apply to well-known and common taxa. Although this is a general phenomenon in all groups of organisms, it may be particularly pronounced in coprinoid fungi, because this group has been central in research in consequence of the practical importance of certain taxa as model organisms. Type revisions of other groups of coprinoid fungi show that many of the currently well-established names have older, validly published synonyms (Nagy, unpublished). Similarly, nomenclatural and taxonomic questions of the genus *Parasola* are far from being settled, and much research is needed to clarify species boundaries and distributions.

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Literature cited

- Bender H, Enderle M. 1988. Studien in der Gattung *Coprinus* (Pers.: Fr.) Gray in der Bundesrepublik Deutschland IV. Zeitsch. F. Mykol. 54: 45–68.
- Breitenbach J, Kränzlin F. 1995. Fungi of Switzerland Vol. 4. Verlag Mykologia, Luzern.
- Buller AHR. 1958. Researches on Fungi. Vol. IV. Further observations on the coprini together with some investigations on social organisation and sex in the hymenomycetes. xx + 360 pp., 149 figs. Canada, Toronto.
- Cacialli G, Caroti V, Doveri F. 1999. Contributio ad cognitionem coprinorum, Monografie di Pagine di Micologia Tomo primo. AMB, Trento.
- Doveri F. 2004. Fungi Fimicoli Italici: A guide to the recognition of basidiomycetes and ascomycetes living on faecal material. AMB, Trento.
- Enderle M, Krieglsteiner GJ, Bender H. 1986. Studien zur Gattung *Coprinus* (Pers.: Fr.) S.F. Gray in der Bunderrepublik Deutschland III. Zeitschr. F Mykol. 52: 101–131.
- Grgurinovic CA. 1997. Larger Fungi of South Australia. The Botanic Gardens of Adelaide and State Herbarium and the Flora and Fauna of South Australia Handbooks Committee, Adelaide, Australia.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum. Ed. 8. New York: New York Botanical Garden 693 pp.
- Josserand M. 1944. Étude sur quelques coprins. Description de deux espèces nouvelles. Bull. trimest. Soc. mycol. Fr. 60: 5–18.
- Josserand M. 1962. *Coprinus miser* (= *C. subtilis*) et *Coprinus plicatilis* sont deux espèces entièrement indépendantes. Bull. trimest. Soc. mycol. Fr. 78: 247–253.
- Kühner R, Josserand M. 1934. Description de quelques espèces du groupe *Coprinus plicatilis* (Curt.) Fr. Bull. Soc. Myc. Fr. 50: 53–63.
- Lanconelli L. 2003. Appunti sut re Coprini molto simili. Micol. e Veget. Medit. 18:116–124.
- Lange JE. 1915. Studies in the agarics of Denmark, part 2. *Amanita*, *Lepiota*, *Coprinus*. Dansk Botanisk Arkiv 2: 1–53.
- Lange JE. 1935. Flora Agaricina Danica. Copenhagen (Reprint Candusso, G. Biella. Saronno. 1993 Vol. 1).
- Larsson E, Örstadius L. 2008. Fourteen coprophilous species of *Psathyrella* identified in the Nordic countries using morphology and nuclear rDNA sequence data, Mycol. Res. 112: 1165–1185; doi: 10.1016/j.mycres.2008.04.003
- Nagy L, Kocsubé S, Papp T, Vágvölgyi Cs. 2009. Phylogeny and character evolution of the coprinoid mushroom genus *Parasola* as inferred from LSU and ITS data. Persoonia 22: 28–37.
- Orton PD. 1969. Notes on British agarics III. Not. Roy. Bot. Gard. 29: 86.
- Orton PD. 1972. Notes on British agarics IV. Not. Roy. Bot. Gard. 32: 139–150.
- Orton PD, Watling R. 1979. *Coprinaceae*, Part 1: *Coprinus*. In British fungus flora Agarics and Boleti (D. M. Henderson, P. D. Orton & R. Watling): 1–149. Royal Botanic Garden, Edinburgh.
- Padamsee M, Matheny BP, Dentinger BTM, McLaughlin DJ. 2008. The mushroom family *Psathyrellaceae*: Evidence for large-scale polyphyly of the genus *Psathyrella*. Mol Phyl Evol 46:415–429.
- Patouillard N. 1886. Tabulae Analyticae Fungorum. Ser. I, fasc. 5. Jules Gindre, Poligny, pp. 181–232.
- Pegler DN. 1968. Studies on African *Agaricales*: I. Kew Bulletin 21(3): 499–533.
- Pegler DN. 1983. Agaric Flora of the Lesser Antilles. Kew Bull. Addit. Ser. 9: 1–668. + 27 plates.
- Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bull. Addit. Ser. 12: 1–519.

- Redhead SA, Vilgalys R, Moncalvo JM, Johnson J, Hopple JS. 2001. *Coprinus* Persoon and the disposition of *Coprinus* species sensu lato. *Taxon* 50: 203–241.
- Roux P. 2006. Mille et un champignon. Ed. Roux, Sainte-Sigolène. 1224 pp.
- Simpson JA, Grgurinovic CA. 2001. The nomenclature of species of *Coprinus* recorded from South Australia. *Australasian Mycologist* 20: 57.
- Smith AH., Hesler LR. 1946. New and unusual dark-spored agarics from North America. *J. Elisha Mitchell Soc.* 62: 177–200, 4 figs.
- Uljé CB. 2005. *Coprinus* In: Noordeloos M.E et al. (eds): *Flora Agaricina Neerlandica* Vol 6. Taylor & Francis
- Uljé CB, Bas C. 1985. *Coprinus hercules* spec. nov. *Persoonia* 12: 482–486.
- Uljé CB, Bas C. 1988. Studies in *Coprinus* I Subsections *Auricomi* and *Glabri* of *Coprinus* section *Pseudocoprinus*. *Persoonia* 13: 433–448.
- Uljé CB, Bender H. 1997. Additional studies in *Coprinus* subsection *Glabri*. *Persoonia* 16: 373–381.
- Uljé CB, Noordeloos ME. 1996. Type studies in *Coprinus* subsect *Alachuani*. *Proc. Kon. Ned. Akad. V. Wetensch.* 99: 105–124.
- Uljé CB, Noordeloos ME. 1997. Studies in *Coprinus* IV. *Coprinus* section *Coprinus*, Subdivision and revision of subsection *Alachuani*. *Persoonia* 16: 265–333.
- Vasutová M, Antonín V, Urban A. 2008. Phylogenetic studies in *Psathyrella* focusing on sections *Pennatae* and *Spadiceae*: new evidence for the paraphyly of the genus, *Mycological Research* 112: 1153–1164 doi: 10.1016/j.mycres.2008.04.005
- Vellinga EC. 1988. Glossary. In: C Bas, THW Kuyper, ME Noordeloos, EC Vellinga (Eds), *Flora Agaricina Neerlandica*, Critical monographs on families of Agarics and Boleti occurring in the Netherlands, vol. 1, A.A. Balkema, Rotterdam. pp. 54–64.
- Vila J, Rocabruna YA. 1996. Aportación al conocimiento del género *Coprinus* Pers. en Cataluna. II. *Rev. Catalana Micologia* 20: 73–90
- Watling R. 1967. Notes on some British agarics. *Notes R. Bot. Gdn Edinb.* 28: 39–56.

Three new species of *Septobasidium* (Septobasidiaceae) from Gaoligong Mountains in China

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Abstract — Three new species, *Septobasidium gaoligongense* and *S. euryae-groffii* on *Eurya groffii* associated with *Pinnaspis* spp. and *Septobasidium polygoni* on *Polygonum campanulatum* associated with *Pseudaulacaspis kuisiuensis*, are described. They were collected from Gaoligong Mountains in Yunnan Province, China.

Key words — *Pucciniomycetes*, *Septobasidiales*, taxonomy

Previously, a new species of *Septobasidium* was found in Gaoligong Mountains of Yunnan province (Lu & Guo 2009b). From the same area an additional three new species are described as follows:

Septobasidium gaoligongense C.X. Lu & L. Guo, sp. nov.

FIGS. 1–6

MYCOBANK MB 516523

Basidiomata resupinata, 15–20 cm longa, 7.5–8 cm lata, cinnamomeo-brunnea, brunnea vel atrobrunnea, margine determinata, superficie laevia, maturitate fissurata, in sectione primum (260–)525–580 µm crassa, deinde 1360–5000 µm crassa. Subiculum brunneum, 30–50 µm crassum. Contextus 2–3-stratosus. Columnae hyalinae vel brunneolae, primum 190–430 µm longae, deinde 3000–4900 µm longae, 290–340 µm latae, ex hyphis 3–5 µm latis compositae. Hymenium hyalinum, 40–50 µm crassum. Basidia fusiformia, cylindrica vel leviter irregularia, recta vel leviter curvata, 4-cellularia, 17–26 × 4–7 µm, hyalina vel brunnea. Sine probasidio. Basidiosporae non visae. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Eurya groffii* Merr. (*Theaceae*): China, Yunnan, Gaoligong Mountains, Baoshan, Baihualin, alt. 1400 m, 8.VII.2009, T.G. Hou 17, HMAS 199577 (holotype), associated with *Pinnaspis* sp. (*Diaspididae*).

*corresponding author

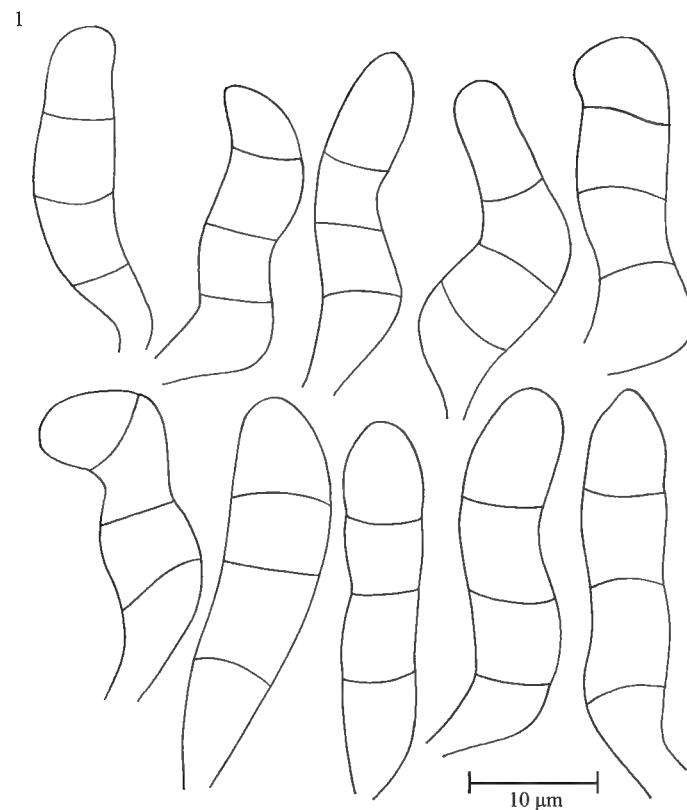
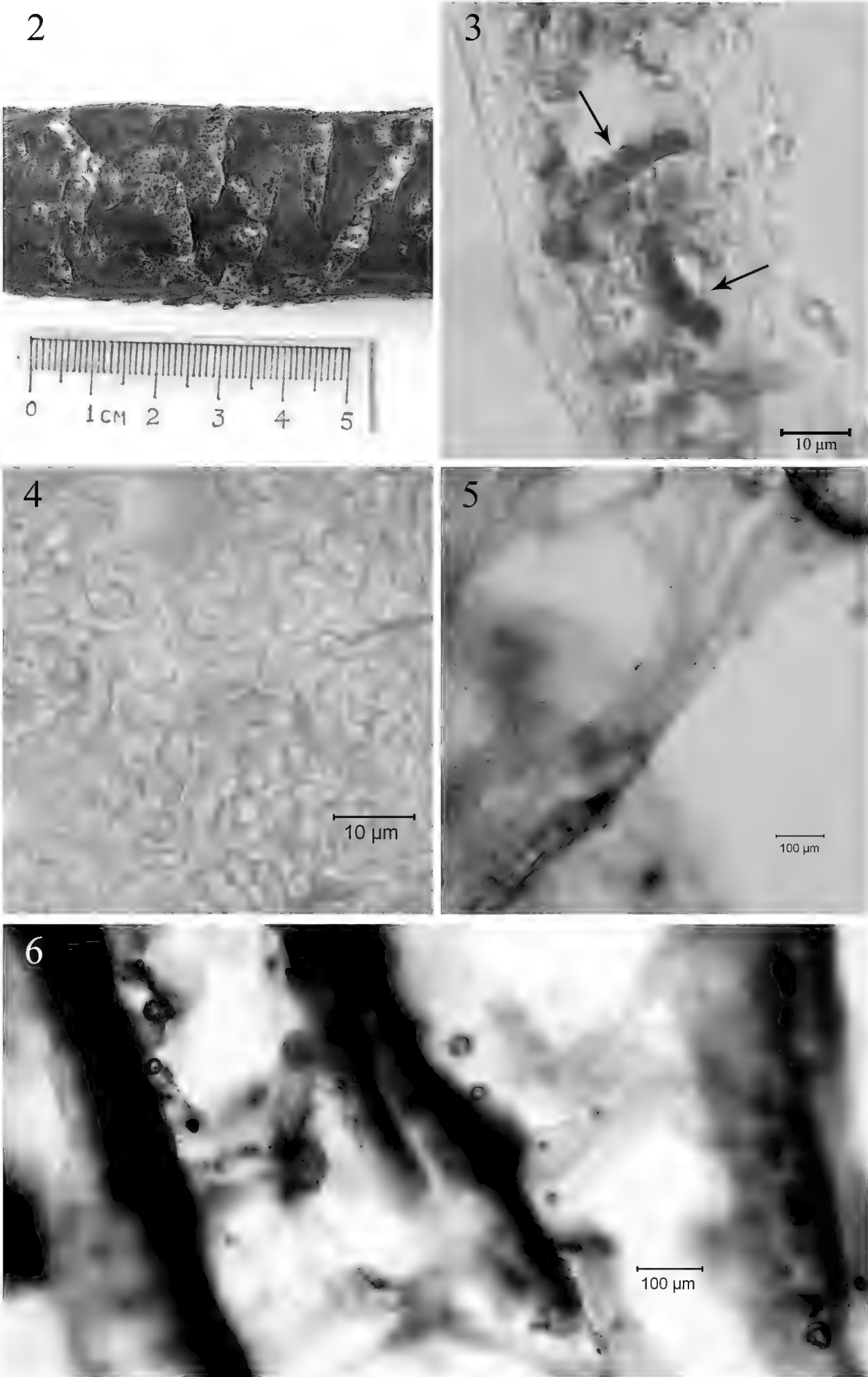


FIG. 1. Basidia of *Septobasidium gaoligongense* (HMAS 199577, holotype).

Basidiomata on branches, resupinate, 15–20 cm long, 7.5–8 cm wide, cinnamon-brown, brown or dark brown; margin determinate; surface smooth at first, becoming cracked at maturity. In section (260–)525–580 μm thick in the young stage and 1360–5000 μm thick in the old stage. Subiculum 30–50 μm thick, brown. Pillars 190–430 μm high in the young stage, 3000–4900 μm high in the old stage, 290–340 μm wide, hyphae of pillars 3–5 μm thick, hyaline or brownish, forming 2–3 horizontal layers. Hymenium 40–50 μm thick, hyaline. Basidia arising directly from the hyphae, fusiform, cylindrical or slightly irregular, straight or slightly curved, 4-celled, $17\text{--}26 \times 4\text{--}7 \mu\text{m}$, hyaline or brown, without a probasidial cell. Basidiospores not seen. Haustoria consisting of irregularly coiled hyphae.

REMARKS: Morphologically, *S. gaoligongense* is similar to *S. crinitum* (Fr.) Couch, but differs mainly in forming 2–3 horizontal hyphal layers, having smaller basidia ($17\text{--}26 \times 4\text{--}7 \mu\text{m}$ vs $40\text{--}55 \times 8.4\text{--}10 \mu\text{m}$), and lacking a top layer. *Septobasidium crinitum* has a thick top layer (100–200 μm high), and lacks horizontal layers.

FIGS. 2–6. *Septobasidium gaoligongense* (HMAS 199577, holotype). 2. Basidiomata on branches. 3. Basidia (arrows). 4. Haustoria. 5. Pillars. 6. Section of basidioma.

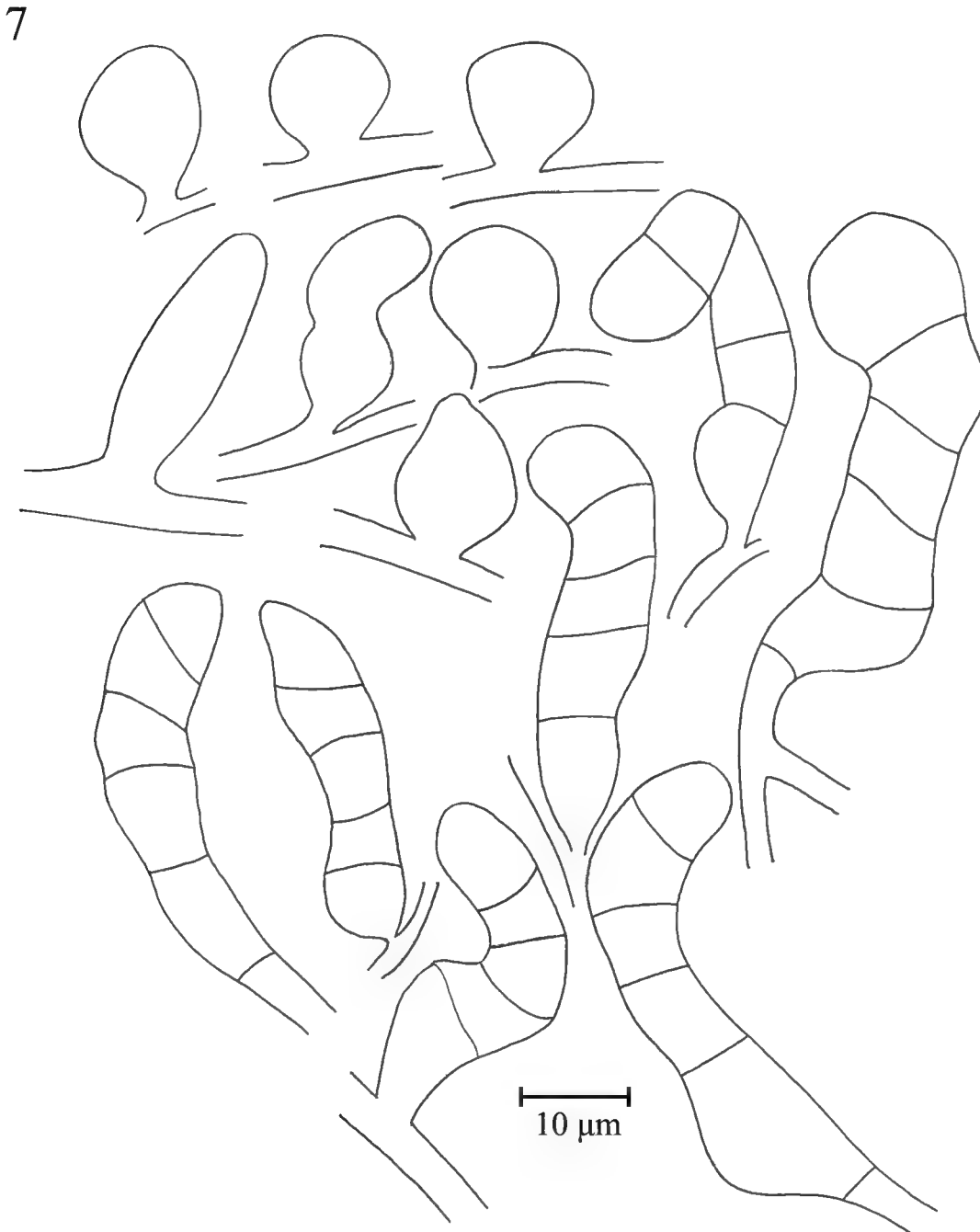


Septobasidium polygoni C.X. Lu & L. Guo, sp. nov.

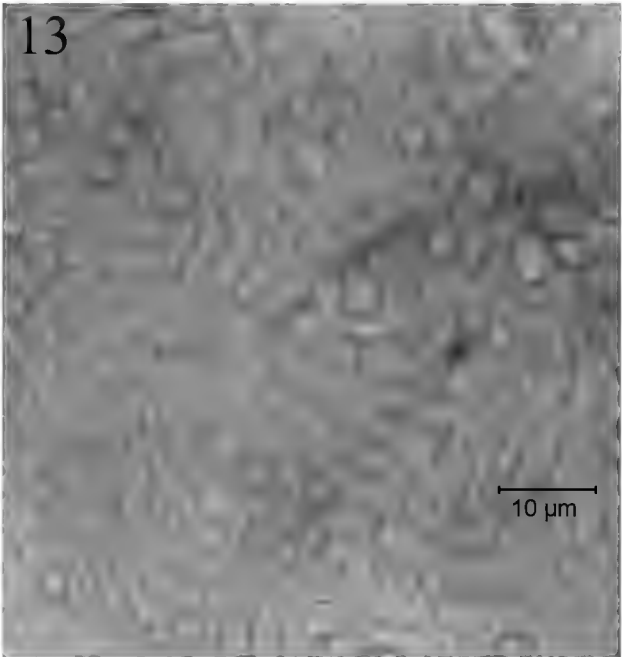
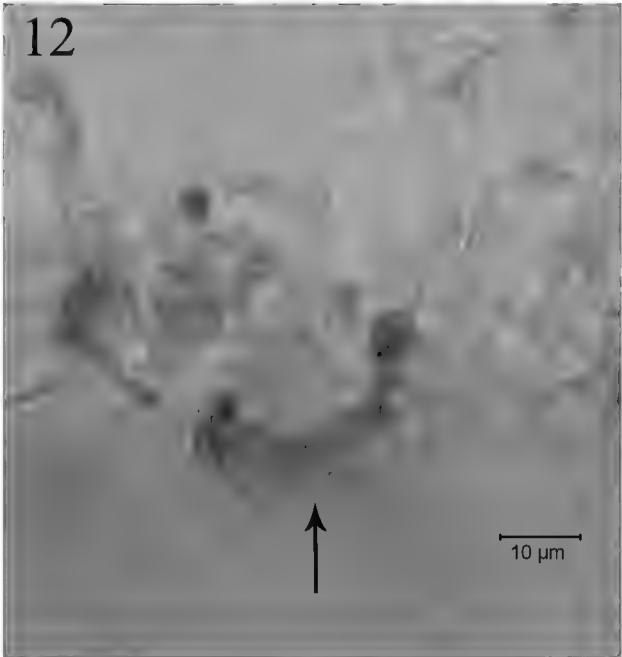
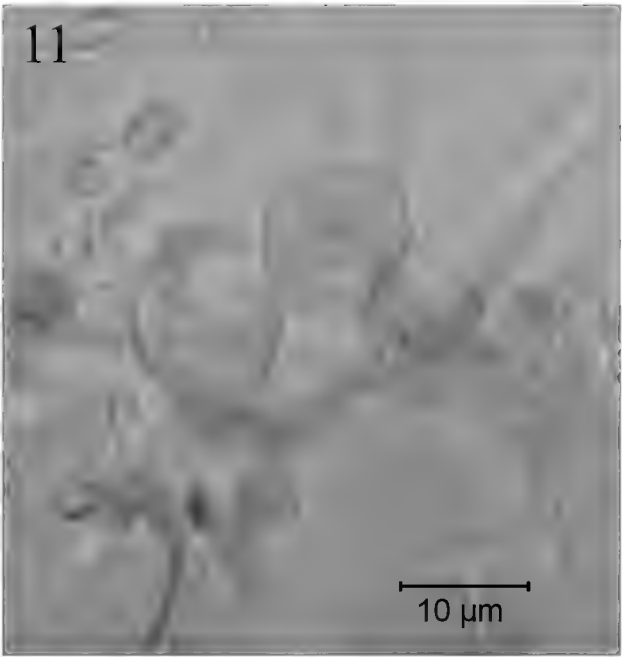
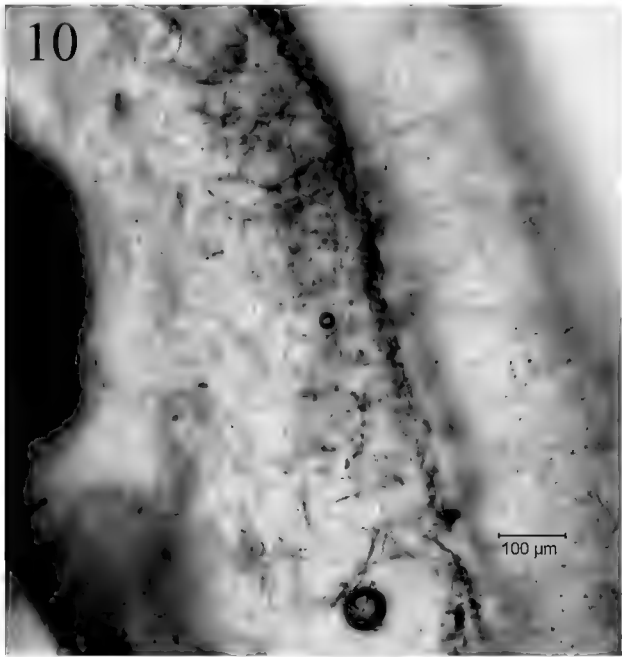
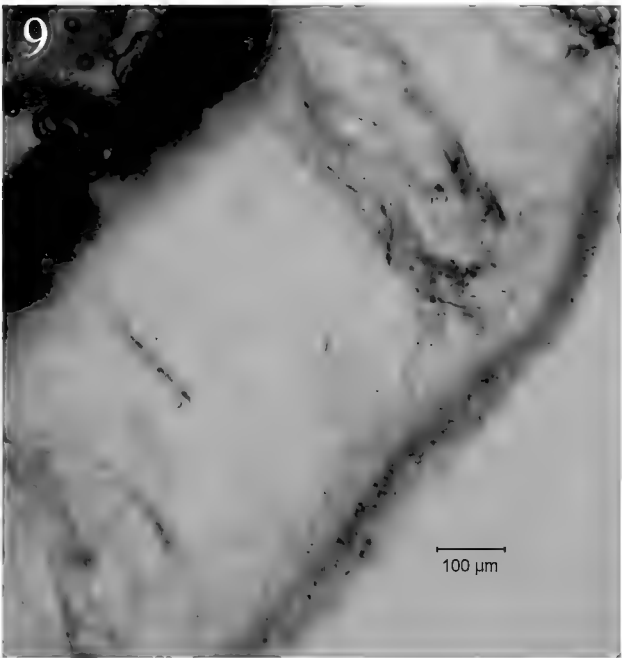
FIGS. 7–13

MYCOBANK MB 516524

Basidiomata resupinata, 2–15.5 cm longa, 1–3 cm lata, alba, cinnamomeo-brunnea vel brunnea, margine determinata, superficie laevia, in vetustate separata, in sectione 390–1550 μm crassa. Subiculum hyalinum vel brunneum, 30–100 μm crassum. Columnae hyalinae vel brunneae, primum 50–80 μm altae, deinde 440 μm altae, 30–70 μm crassae vel hyphis laxae completae, interdum hyphae repullulantes, super hymenium stratum

FIG. 7. Probasidia and basidia of *Septobasidium polygoni* (HMAS 196488, holotype).

FIGS. 8–13. *Septobasidium polygoni* (HMAS 196488, holotype). 8. Basidiomata on branches. 9–10. Sections of basidiomata. 11. Probasidia. 12. Basidium (arrow). 13. Haustoria.



hypharum secundum 50–200 µm altum formantes. Hymenium 50–100 µm crassum, unistratosum vel 2-stratosum. Probasidia subglobosa vel pyriformia, 10–17 × 10–15 µm, subhyalina vel flavidobrunnea, persistentia. Basidia cylindrica, curvata, 4-cellularia, 24.5–34 × 7.5–10 µm, hyalina or flavidobrunnea. Basidiosporae non visae. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Polygonum campanulatum* Hook. f. (*Polygonaceae*): China, Yunnan, Gaoligong Mountains, Tengchong, alt. 2050 m, 5.IX.2008, S.H. He, Y.F. Zhu & L. Guo 2371, HMAS 196488 (**holotype**), associated with *Pseudaulacaspis kuisiuiensis* (*Diaspididae*).

Basidiomata on stems and branches, resupinate, 2–15.5 cm long, 1–3 cm wide, white, cinnamon-brown or brown; margin determinate; surface smooth, peeling off in old stage. In section 390–1550 µm thick. Subiculum hyaline or brown, 30–100 µm thick. Pillars hyaline or brown, 50–80 µm high in young stage, up to 440 µm high in old stage, 30–70 µm wide, or loosely filled with 220–400 µm high hyphae, sometimes from hymenial layer the fungal hyphae renews growth to form a second hyphal layer, 50–200 µm high. Hymenial layer 50–100 µm thick, single or 2-stratose. Probasidia subglobose or pyriform, 10–17 × 10–15 µm, subhyaline or pale yellowish brown; probasidial cell persistent after the formation of the basidia. Basidia cylindrical, curved, 4-celled, 24.5–34 × 7.5–10 µm, hyaline or yellowish brown. Basidiospores not seen. Haustoria consisting of irregularly coiled hyphae.

REMARKS: Morphologically, *S. polygoni* is similar to *S. citricola* Sawada from which it differs in having tall pillars (up to 440 µm vs 84–126 µm), a thinner hymenium (50–100 µm vs 100–390 µm), and smaller basidia (24.5–34 × 7.5–10 µm vs 50–65 × 8.2–9.7 µm).

***Septobasidium euryae-groffii* C.X. Lu & L. Guo, sp. nov.**

FIGS. 14–19

MYCOBANK MB 516525

Basidiomata resupinata, 5–16 cm longa, 4–11 cm lata, cinnamomeo-brunnea, brunnea vel castaneo-brunnea, margine determinata, superficie laevia et protuberantia, deinde fissurata, in sectione 1260–2620 µm crassa, 3–12-stratosa. Subiculum 40–50 µm crassum, brunneum. Columnae 40–100 altae, 50–165 µm latae, superne ramosae tunc strato hypharum 360–560 µm alto formantae, hyphae repullulantes tum duo strata horizontalia 130–180 µm alta formantes. Hymenium 50–60 µm crassum. Interdum super hymenium columnae secundae 60–110 µm altae formatae et strata hypharum 4-stratosa 810–1050 µm alta successive superposita. Hymenium denuo formatum 70–110 µm altum. Basidia cylindrica, recta vel leviter curvata, 4-cellularia, 20–45 × 5–8 µm, hyalina or brunneola. Sterigmata conica, 2–3 µm longa. Sine probasidio. Basidiosporae non visae. Haustoria ex hyphis irregulariter spiralibus constantia.

TYPE: On *Eurya groffii* Merr. (*Theaceae*): China, Yunnan, Gaoligong Mountains, Baoshan, Baihualin, alt. 1400 m, 8.VII.2009, T.G. Hou 21, HMAS 199579 (**holotype**), associated with *Pinnaaspis* sp. (*Diaspididae*).

Basidiomata on branches, resupinate, perennial, 5–16 cm long, 4–11 cm wide, cinnamon brown, brown or chestnut brown; margin determinate; surface

14

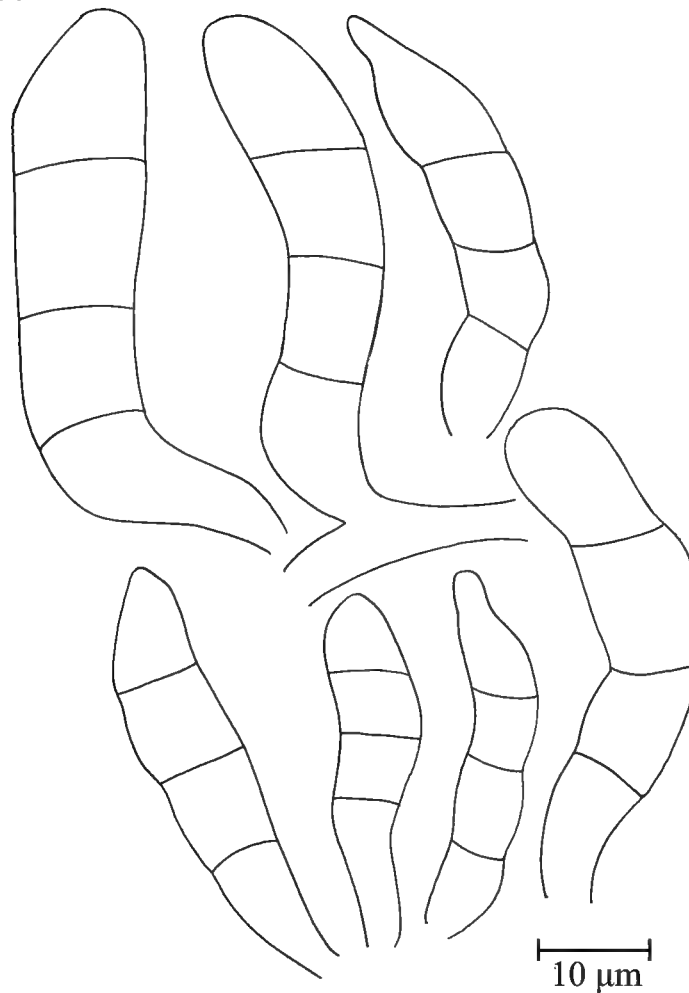
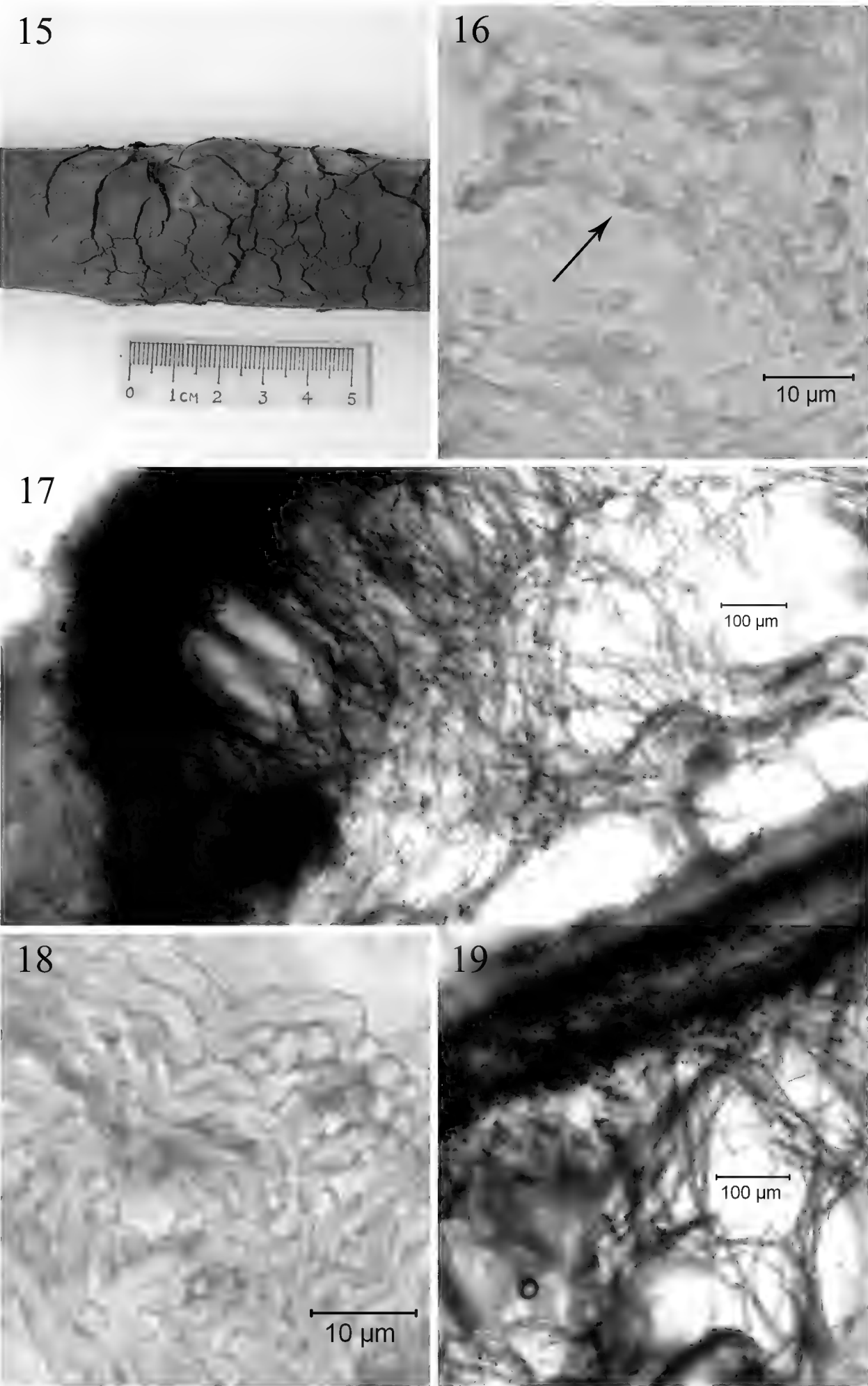


FIG. 14. Basidia of *Septobasidium euryae-groffii* (HMAS 199579, holotype).

smooth and protuberant, becoming cracked later. In section 1260–2620 μm thick, composed of 3–12 layers. Subiculum 40–50 μm thick, brown. Pillars 40–100 μm high, 50–165 μm wide, branched outwards to form a hyphal layer 360–560 μm high, the hyphae renewing to form two horizontal layers 130–180 μm high, forming a hymenial layer 50–60 μm thick at the upper, with closely packed parallel upright threads. Sometimes from the hymenium successively forming pillars 60–110 μm high, and 4 hyphal layers 810–1050 μm high. Hymenial layer renewing, up to 70–110 μm high. Basidia arising directly from the hyphae without a probasidial cell, cylindrical, straight or slightly curved, 4-celled, $20\text{--}45 \times 5\text{--}8 \mu\text{m}$, hyaline or brownish. Sterigmata coniform, 2–3 μm long. Basidiospores not seen. Haustoria consisting of irregularly coiled hyphae.

REMARKS: *Septobasidium euryae-groffii* is similar to *S. henningsii* Pat., from which it differs in producing shorter pillars (40–110 μm vs 300–1100 μm) and shorter sterigmata (3–5 μm vs 14–34 μm). In addition, the basidioma surface of *S. euryae-groffii* is bumpy whereas that of *S. henningsii* is smooth. Another similar species, *S. thwaitesii* (Berk. & Broome) Pat., has curved basidia and probasidial cells.



Excluded species

Septobasidium parlatoriae Sawada, Rep. Dept. Agric. Govt. Res. Inst. Formosa. 51: 57, 1931.

A study of the type specimen of *S. parlatoriae*, borrowed from TAI, showed that no scale insects are present beneath the fungal hyphae. It is an anamorphic fungus.

To date, 23 species of *Septobasidium* have been reported in China (Sawada 1933, Couch 1938, Teng 1963, Tai 1979, Kirschner & Chen 2007, Lu & Guo 2009a, b,c, Lu et al. 2010), including the three species reported in this paper.

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Literature cited

- Couch JN. 1938. The Genus *Septobasidium*. Univ. of North Carolina Press, Chapel Hill. 480 p.
- Kirschner R, Chen CJ. 2007. New reports of two hypophyllous *Septobasidium* species from Taiwan. Fung. Sci. 22(1,2): 39–46.
- Lu CX, Guo L. 2009a. *Septobasidium maesae* sp. nov. (*Septobasidiaceae*) from China. Mycotaxon 109: 103–106.
- Lu CX, Guo L. 2009b. Two new species of *Septobasidium* (*Septobasidiaceae*) from China. Mycotaxon 109: 477–482.
- Lu CX, Guo L. 2009c. *Septobasidium annulatum* sp. nov. (*Septobasidiaceae*) and *Septobasidium kameii* new to China. Mycotaxon 110: 239–245.
- Lu CX, Guo L, Wei JG, Li JB. 2010. Two new species of *Septobasidium* (*Septobasidiaceae*) from southern China. Mycotaxon 111: 269–271.
- Sawada K. 1933. Descriptive catalogue of the Formosan fungi. Part VI. Rep. Dept. Agric. Govt. Res. Inst. Formosa 61: 1–99.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Science Press, Beijing. 1527 p.
- Teng SC. 1963. Fungi of China. Science Press, Beijing. 808 p.

FIGS. 15–19. *Septobasidium euryae-groffii* (HMAS 199579, holotype). 15. Basidiomata on branches. 16. Basidia (arrow). 17, 19. Sections of basidiomata. 18. Haustoria.

Peniophora pseudonuda* is a synonym of *P. laeta

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Abstract — *Peniophora laeta* is easily recognized because it is restricted to *Carpinus* as host in Europe, and the reddish yellow basidioma is provided with prominent teeth or hyphal pegs, disrupting the bark when developing. *P. pseudonuda* was earlier not even thought of as related to *P. laeta*, because basidiomata are smooth and developing on the bark. Moreover, basidioma initiation starts with a thin layer of brown-pigmented hyphae on the bark surface. This gives a bluish tint to the mature basidioma, which is in striking contrast to the orange-yellow basidiomata found in *P. laeta*. Nevertheless, both ITS sequences and crossing tests show that *P. pseudonuda* is conspecific with *P. laeta*. This was supported also by similarities in spores, basidia, and cystidia morphology.

Key words — *Corticiaceae*, epicortical basidiomata, spore morphometrics

Introduction

The corticioid fungus *Peniophora pseudonuda* was described in 1980, firstly as a species with restricted natural range, known from hyrcanian forests of northern Iran, in Elburz Mountains (Hallenberg 1980). Later it was collected and published from the northwestern part of Main Caucasus, in Krasnodar Province, Russia, in temperate broadleaved communities of *Quercus*, *Fagus*, and *Fagus-Abies* forest belts (Mukhamedshin 1992, Hallenberg et al. 1996). The species epithet reminds on the presence of wide broadly clavate gloeocystidia,

* corresponding author

similar to those in *P. nuda* (Fr.) Bres. The brown-pigmentation of hyphae in the subiculum was a reason why this taxon was referred to the subgenus *Peniophora* (Boidin 1994).

Peniophora laeta is a fungus distributed in Europe and Pacific part of North America (Ginns & Lefebvre 1993, Boidin 1994). Until 1957 *P. laeta* was not distinguished from *P. incarnata* s. l. (Donk 1957), and due to light-pigmented hyphae it has been referred to the subgenus *Gloeopeniophora*.

Materials and methods

Morphology

Specimens were studied in 5% potassium hydroxide (KOH), Melzer's reagent (IKI) and Cotton Blue in lactic acid (CB). Measurements and drawings were made in KOH solution; spore measurements are based on at least thirty spores. In each range, the values in the parentheses are 10% of variation extremes.

Sampling and crossing tests

The specimens studied (Table 1) were selected from the FCUG culture collection (<http://www.systbot.gu.se/database/FCUG/FCUG.html>) at the University of Gothenburg (Sweden).

Crossing tests were restricted to specimens for which non-clamped single spore isolates were available. Single-spore mycelia from different specimens were placed in pairs on malt-extract agar (1.25% malt extract) and left in room temperature for three weeks. From each specimen, two to four single-spore mycelia were used. Paired cultures were checked for clamp formation in three different regions: at the immediate contact zone and on opposite sides of the inocula, some 20 mm from respective inoculum. Plates with negative results were re-checked after an additional three weeks.

DNA extraction, amplification, and sequencing

For crossing tests and as a source of DNA extraction, single-spore mycelium was isolated, cultivated on malt agar plates (1.25% malt extract), and subsequently placed in malt liquid solution (malt extract as above) for three weeks. When single-spore mycelium was not available, polyspore mycelium was used. Mycelia were harvested and dried between sheets of sterile filter paper; approximately 2 mg (dry-weight) of input mycelium were used per specimen. DNA extraction was accomplished using the DNeasy® Plant Mini Kit (QIAGEN®); during this and the following steps of the DNA preparation, purification, and sequencing, the recommendations of the respective manufacturer were followed.

The polymerase chain reactions were carried out using Ready-To-Go™ PCR Beads kits (Amersham Pharmacia Biotech), a Biometra TRIO-Thermoblock (Biometra, Germany), the PCR primers ITS1F and ITS4B, and the PCR set-up of Gardes & Bruns (1993). The PCR product was purified using QIAquick™ Spin procedure (QIAGEN®) and the sequence reactions were conducted using 100 ng of template DNA and the CEQ 2000 Dye Terminator Cycle Sequencing with Quick Start Kit (Beckman Coulter). Sequences were obtained using the CEQ 2000XL DNA Analysis System (Beckman Coulter).

Results and discussion

Molecular divergence and crossing tests

The ITS1 and ITS2 sequences were aligned manually and divergence was small. In total, the maximum variation between the samples in TABLE 1 were 1.9%, which is clearly within intraspecific variation (Nilsson et al. 2008). Moreover, crossing tests indicated conspecificity between the two species (TABLE 2).

TABLE 1. Details of the studied specimens. The substrate is specified to the extent known. The abbreviation ‘dec.’ refers to deciduous wood. FCUG numbers in bold were used for crossing tests.

TAXON / FCUG NR.	LOCALITY	SUBSTRATUM	OTHER NUMBER	GENBANK
<i>Peniophora laeta</i>				
FCUG 1005	Romania, Iasi	<i>Carpinus</i>	NH 7998	GU322862
FCUG 1266	Sweden, Scania	<i>Carpinus</i>	NH 8557	GU322861
FCUG 1475	Romania, Cluj	dec. wood	NH 9358	GU322864
FCUG 1905	Sweden, Öland	<i>Carpinus</i>	EL 87-1	GU322860
FCUG 2729	Russia, Krasnodar	<i>Carpinus</i>	NH 13150	GU322863
<i>Peniophora pseudonuda</i>				
FCUG 86	Iran, Golestan	dec. wood	NH 2555	GU322867
FCUG 2384	Russia, Krasnodar	dec. wood	NH 12298	GU322866
FCUG 2390	Russia, Krasnodar	<i>Carpinus</i>	NH 12003	GU322865
FCUG 2664	Russia, Krasnodar	dec. wood	NH 12930	GU322868
FCUG 2681	Russia, Krasnodar	<i>Carpinus</i>	NH 12978	GU322869

TABLE 2. Results of crossing tests. All performed crossings resulted in clamp formation (+).

TAXON	SUBSTRATUM	FCUG CULTURE	1005	1266	1475	1905	2729	2384	2390
<i>P. laeta</i>	<i>Carpinus</i>	1005		+	+	+	+	+	+
<i>P. laeta</i>	<i>Carpinus</i>	1266			+	+	+	+	+
<i>P. laeta</i>	deciduous wood	1475				+	+	+	+
<i>P. laeta</i>	<i>Carpinus</i>	1905					+	+	+
<i>P. laeta</i>	<i>Carpinus</i>	2729						+	+
<i>P. pseudonuda</i>	deciduous wood	2384							+
<i>P. pseudonuda</i>	<i>Carpinus</i>	2390							
<i>P. pseudonuda</i>	deciduous wood	86						+	+

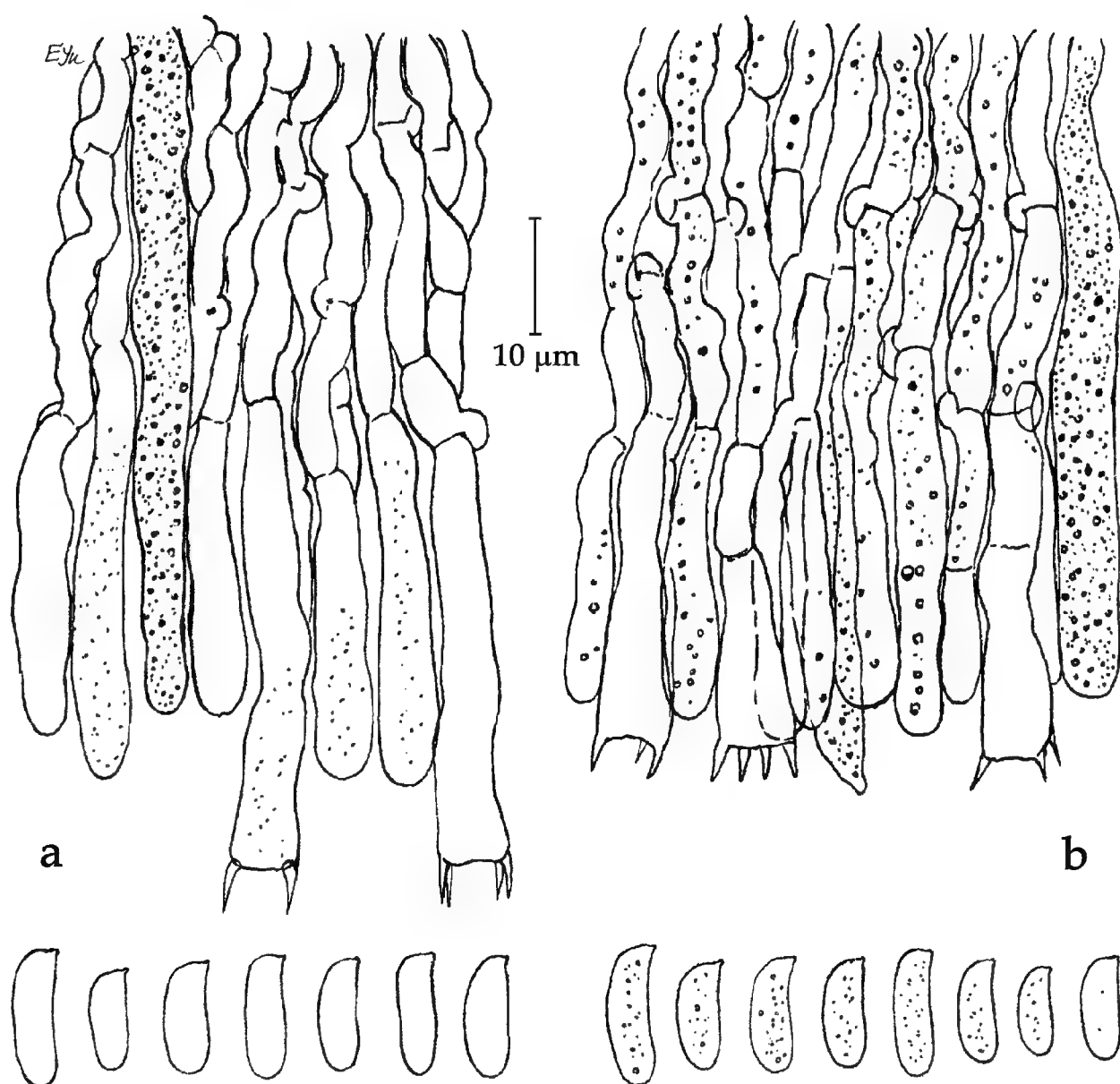


FIG. 1. Hymenium, subbasidial hyphae, and basidiospores in *Peniophora pseudonuda* (a, GB12298/FCUG 2384) and *P. laeta* (b, MSK 6943). Depending on the view, only 2 or 3 sterigmata of 4 are visible on basidia.

Macromorphologically, decorticating samples are well distinguished from non-decorticating: they have wart-like to hydroid hymenophore projections, hymenophore color varies from pinkish or cream to light ochraceous. Basidiomata of *P. pseudonuda* always develop epicortically, hymenial surface is smooth, and the color varies from whitish cream with brownish hue to pale ochraceous and bluish grey. Thus, hymenium colors are partly overlapping in the two taxa.

On the other hand, the comparison of basidioma micromorphology of *P. pseudonuda* and *P. laeta* has shown a notable similarity in several characters. The shapes of spores and basidia are indistinguishable and hyphae are also very similar (FIG. 1). Morphometrics of the spores have demonstrated that there is

TABLE 3. Spore sizes in *Peniophora laeta* samples.

BASIDIOMA GROWTH HABIT*	REFERENCE COLLECTION NR.	REGION / LATITUDE	SPORE SIZE RANGE / ARITHMETICAL MEANS (N=30), µm
d	FCUG 1266/ NH 8557	Sweden, Scania/ 56° N	(9.8–)10.6–12(–12.5) × (3.1–)3.3–4.2(–4.5)
d	MSK-F 6738	Belarus, Asipovichy / 53.3° N	7.5–11 × 2.7–4.1 / 8.79 × 3.31
d	MSK-F 7076	Belarus, Hlusk / 52.8° N	8–11.4 × 2.8–4.2 / 9.66 × 3.36
d	MSK-F 4560	Belarus, Petrykau / 52.2° N	8–11.5 × 2.2–3.7 8.87 × 3.08
d	KW 17598	Ukraine, Kyiv / 50° N	8.1–11.5 × 2.8–4.2 / 9.66 × 3.59
d	CWU(myc) Ch-24	Ukraine, Cherkasy / 49.7° N	7.6–11.2 × 2.2–4.1 / 9.21 × 3.05
d	KW 17590	Ukraine, Kirovhrad / 48.4° N	8.7–12.8 × 3–4.5 / 10.15 × 3.59
d	MSK-F 5981	Ukraine, Crimea / 45° N	7.5–11.7 × 2.5–4.1 / 9.28 × 3.29
nd	FCUG 2384/ NH12298	Russia, Krasnodar / 44° N	7.2–11.2 × 2.2–3.7 / 9.01 × 3.00
nd	MSK 6688	Russia, Stavropol' / 43.9° N	7.2–10.6 × 2.7–3.5 / 8.79 × 3.12
nd	Ghobad-Nejhad 413	Iran, E. Azerbaijan / 38.8° N	(8.3–)9–12(–13) × (3–)3.5–4.4(–5)
nd	FCUG 86/ NH2555	Iran, Golestan / 37.3° N	10–12(–13) × 4–5

* d – decorticating; nd – non-decorticating. The same abbreviations in SPECIMENS EXAMINED.

no distinction that can be treated as specific (TABLE 3). Besides, variation in spore size does not display any dependence on geographical latitude.

Gloeocystidia are of variable morphology, depending on the age of basidioma and their position in certain parts of the basidioma. *P. pseudonuda* has numerous ellipsoid-clavate gloeocystidia, while *P. laeta* has predominantly subcylindrical ones, but all shapes of gloeocystidia which were observed in *P. pseudonuda*, were also found in *P. laeta* though in different frequency (FIG. 2, 3). Lamprocystidia are rare or scattered in both taxa, but usually more frequent in *P. pseudonuda*. The main micromorphological difference between them is the composition of subiculum. In *P. pseudonuda* there is a more or less pronounced basal layer, always of compact, agglutinated hyphae, while in *P. laeta* three different types of subicular layers can be recognized: (1) a more or less thin layer of compact subhorizontal hyphae (FIG. 3), (2) a much thicker layer of intertwined and loosely arranged hyphae (FIG. 4a), and (3) a layer of wide, short-celled hyphae, agglutinated and parallelly arranged, forming a

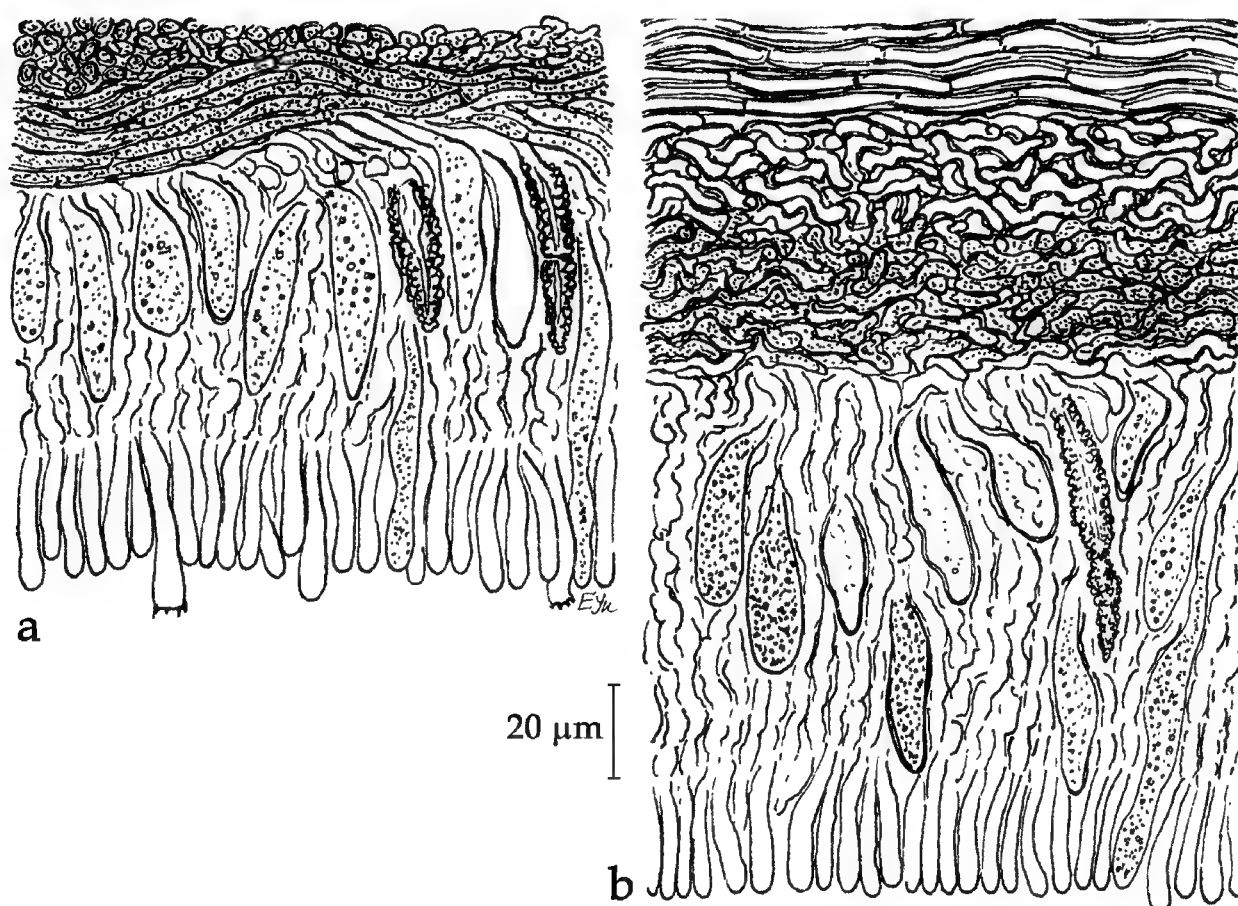


FIG. 2. Vertical basidioma sections in *Peniophora pseudonuda* (GB12298/FCUG 2384): a – in thinner part, with brown compact basal layer, b – in thicker part, with hyaline to brownish, less compact subicular hyphae.

pseudoparenchymatous tissue. The last type of subiculum occurs as tramal tissue in the teeth of the hymenophore (FIG. 4b). Subicular hyphae in *P. laeta* are usually hyaline or subhyaline, but in old basidiomata some hyphae become yellow or yellow-brown, like in *P. pseudonuda*.

We regard the differences in subiculum organization as an adaptation to subcortical or epicortical growth. In order to break and uplift the bark to expose the hymenium, the fungus develops hydroid projections, together with thicker and looser subiculum, often containing the characteristic pseudoparenchyma. On twigs with thin bark and/or with few or no lenticels, the fungus can easily break the bark layer. However, on twigs with firm bark the fungal mycelium emerges through bark holes, apparently not being able to rupture the bark. The brown pigmentation of the epicortical subiculum in *P. pseudonuda* is considered as an adaptation to light exposure. It is well known from other *Peniophora* species that a brown subicular layer may yield a basidioma with a brownish grey or bluish grey color of the hymenium (Eriksson et al. 1978). Contrary, the basidiomata of *P. laeta* are partly covered from direct sunlight during the subcortical basidioma formation and the subicular layer consists of hyaline or subhyaline hyphae. Based on samples collected in Eurasia from Sweden to Iran, an emended morphological description of *P. laeta* has been constructed.

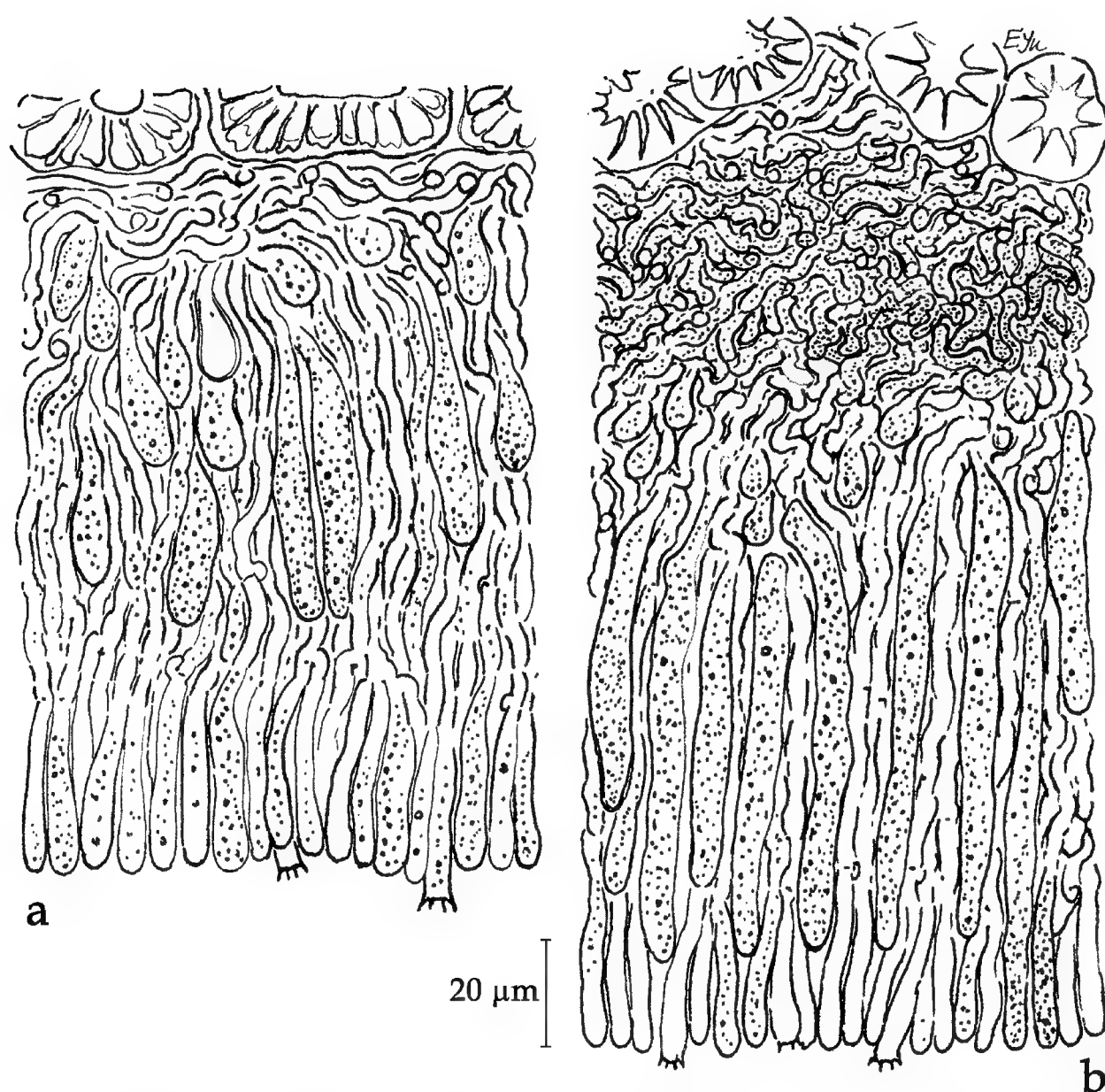


FIG. 3. Vertical basidioma sections in *Peniophora laeta* (MSK 6943): a – in thinner part, with scarce hyaline subicular hyphae, b – in thicker part, with moderately developed yellow compact subiculum and elongated gloeocystidia.

Peniophora laeta (Fr.) Donk
= *Peniophora pseudonuda* Hallenb.

FIGS. 1–4

BASIDIOMA annual, resupinate, closely adnate, developing under the bark and extending through and rupturing the bark upon growth, or – alternatively – extending on bark and soon becoming confluent, ceraceous, 80–150 µm thick in smooth parts; hymenium surface pruinose under a lens, color variable – creamish, creamish-orange with reddish tint, or bluish grey; hymenophore smooth to irregularly tuberculate-odontoid, teeth scattered, up to 2.5 mm long and 1 mm wide, occasionally joined and aggregated; margin abrupt to thinning out.

HYPHAL SYSTEM monomitic, hyphae with clamps, arranged vertically in subhymenium, 3–4 µm wide, thin-walled, not changed in KOH. Subiculum 40–400 µm thick, almost lacking in some collections; texture variable, from dense, consisting of agglutinated golden brown hyphae, to pseudoparenchymatous in the centre of teeth, or composed of loose and intertwined, subhyaline hyphae. **CYSTIDIA** of two types: 1) gloeocystidia, 40–115 × 9–20 µm, often developing deeply in the subhymenium, vesicular-clavate, becoming elongate, and reaching the hymenial surface, contents refractive, granular to homogeneous, walls thin to moderately thickened, 2) metuloids (encrusted pointed cystidia), also developing deeply in the subhymenium, rare or even lacking in some collections, crystallized part 15–37 × (7.5–)10–12 µm. A few naked and pointed cystidia are sometimes present among the basidia, only slightly projecting above the hymenium. **BASIDIA** subcylindrical to narrowly clavate, little flexuose, 35–50 × 5–6.5 µm, with a basal clamp, with four sterigmata, walls slightly thickened in mature basidia. **SPORES** subcylindrical, slightly depressed adaxially, (7.2–)8–11.5(–13) × (2.2–)3–4.5(–5) µm, with a small apiculus, contents hyaline or subhyaline, walls smooth, thin, CB+, IKI–.

SUBSTRATA — On dead, still-attached, sometimes fallen, thin (0.2–1.5 cm) twigs and branches of hardwood trees. In Europe mostly found on *Carpinus betulus*, occasionally *Quercus robur*; in W. Asia also found on *Corylus avellana*, *Fagus orientalis*, *Parrotia*, *Quercus*. In North America it has only been recorded from *Amelanchier*, which suggests that this material needs to be re-examined.

SPECIMENS EXAMINED — **BELARUS:** Mahilyou oblast, ASIPOVICHY, BRYTSALAVICHY, on *Carpinus*, 6.IX.2006, Yurchenko (MSK-F 6738; d); Minsk oblast, SALIHORSK, HOTS, on *Carpinus*, 20.VI.2008, Yurchenko (MSK-F 6943); HLUSK, SLAUKAVICHY, on *Carpinus*, 1.X.2008, Yurchenko (MSK-F 7076; d); Homel' oblast, PETRYKAU, ADASI, on *Carpinus*, 19.X.1998, Yurchenko (MSK-F 4560; d). **GEORGIA:** COLCHIS, KULO, alt. 1200 m, on *Corylus avellana*, 5.X.1963 Parmasto (TAA 16745; nd). **IRAN:** E. Azerbaijan, W. KALEIBAR, MAKIDI, on *Carpinus*, 3.X.2006, Ghobad-Nejhad 413A (nd); Golestan, GOLESTAN NATIONAL PARK, on fallen hardwood, 26.IV–8.V.1978, Hallenberg 2555 & Danesh-Pajuh (**HOLOTYPE** of *Peniophora pseudonuda*, GB; nd). **ROMANIA:** CLUJ NEAR POIENI, on *Carpinus*, 23.X.1985, Hallenberg 9358 (GB-0073654; FCUG 1475; d). **RUSSIA:** ADYGEYA, MAYKOP, GUZERIPL', on *Fagus orientalis*, 14.IX.2003, Kotiranta 22517 (HK ref. herb.; dupl. MG ref. herb.; nd); KRASNODAR, MOSTOVSKOJ, PSEBAJ, on fallen hardwood, 15.IX.1991, Hallenberg 12298 (GB-0073645; FCUG 2384; nd); STAVROPOL', KISLOVODSK, on *Carpinus*, 20.VIII.2000, Yurchenko (MSK-F 6688; nd). **SWEDEN:** Gotland, VISBY, DBW BOTANICAL GARDEN, on *Carpinus betulus*, 5.X.1984, Nordin 9428 (H; d); SCANIA, STENSHUVUD, on *Carpinus*, 1.X.1984, Hallenberg 8557 (GB-0073663; FCUG 1266; d). **UKRAINE:** Kyiv oblast, RZHYSHCHIV, HREBENI, on *Carpinus*, 8.IX.1973, Soldatova (KW 17598, dup. in MSK; d); Kirovhrad oblast, HOLOVANIV, on *Carpinus*, 24.VIII.1973, Soldatova (KW 17590; dup. in MSK; d); Cherkasy oblast, KANIV RESERVE, on *Quercus robur* (!), 10.IX.2003, Akulov (CWU myc Ch-24; d); Crimea, SUDAK, LESNOE, 2.VIII.2001, Yurchenko (MSK-F 5981; d).

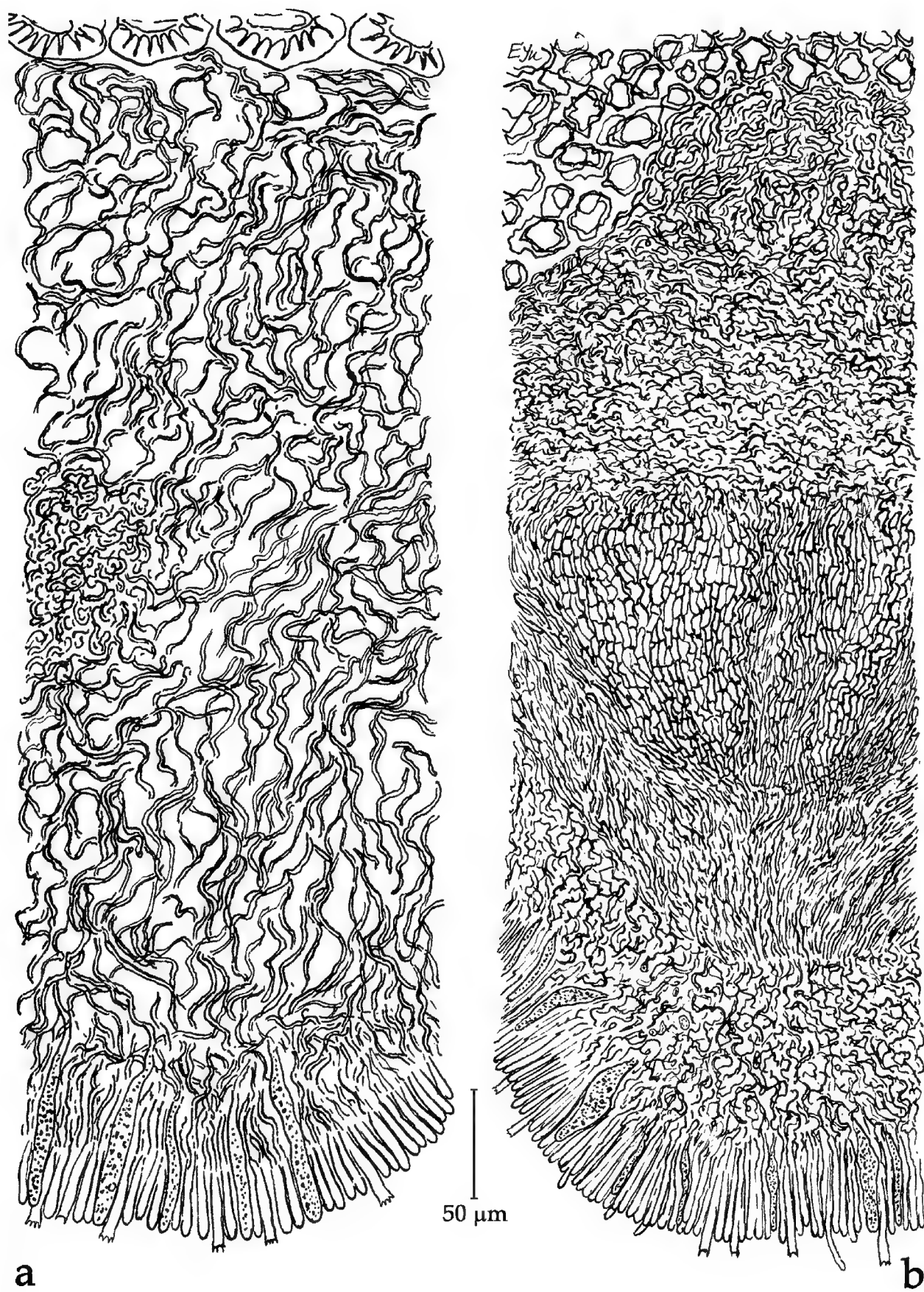


FIG. 4. Vertical basidioma sections in *Peniophora laeta* (MSK 6943) in thicker part and hymenophore projections: a – a portion with subiculum of loose hyaline hyphae, b – a portion with hyaline to yellowish subiculum, with pseudoparenchymatic insertion (center).

Acknowledgments

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Literature cited

- Boidin J. 1994. Les Peniophoraceae des parties tempérées et froides de l'hémisphère nord (*Basidiomycotina*). Bull. Mens. Soc. Linn. Lyon 63(9): 317–334.
- Donk MA. 1957. Notes on resupinate *Hymenomycetes*–IV. Fungus (Wageningen) 27(1–4): 1–29.
- Eriksson J, Hjortstam K, Ryvarden L. 1978. The *Corticaceae* of North Europe. Vol 5. Fungiflora, Oslo.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. Molec. Ecol. 2: 113–118.
- Ginns JH, Lefebvre MNL. 1993. Lignicolous corticioid fungi (*Basidiomycota*) of North America, systematics, distribution, and ecology. Mycol. Mem. No. 19.
- Hallenberg N. 1980. New taxa of *Corticaceae* from N. Iran (*Basidiomycetes*). Mycotaxon 11(2): 447–475.
- Hallenberg N, Larsson E, Mahlapuu M. 1996. Phylogenetic studies in *Peniophora*. Mycol. Res. 100: 179–187.
- Mukhamedshin RK. 1992. *Corticaceae* s. lato in the northwest Caucasus. Mikol. Fitopatol. 26(2): 104–109. (in Russian.)
- Nilsson RH, Kristiansson E, Ryberg M, Hallenberg N, Larsson K-H. 2008. Intraspecific variability in the kingdom fungi as expressed in the international sequence databases and its implications for molecular species identification. Evol. Bioinform. Online 4: 193–201.

A new species of *Pluteus* (*Pluteaceae*, *Agaricales*) from Mexico

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Abstract— A new species, *Pluteus nevadensis* from subtropical and pine forests in Mexico, is described and compared with similar taxa. Phylogenetic analyses of the ITS rDNA sequence data support the classification of this new taxon in *Pluteus* section *Celluloderma*.

Key words— cystidia, *Pluteus aurantiorugosus*, *Pluteus horakianus*

Introduction

Pluteus Fr. is an agaric genus typically classified in the *Pluteaceae* Kotl. & Pouzar (Singer 1986). It is characterized by the free and pink-coloured lamellae, absent volva and annulus, and the convergent lamellar trama. It has a worldwide distribution that includes saprobic species, the majority of them lignicolous.

Until now, 33 species of the genus *Pluteus* have been reported from Mexico. Some of the species that are only known from this country include *Pluteus horridus* Singer, *P. leucocyaneus* Singer, *P. multistriatus* Murrill, *P. nitens* Pat., *P. triplocystis* Singer, and more recently *P. neotropicalis* Rodr.-Alcánt. and *P. horakianus* (Patouillard 1898, Murrill 1911, Singer 1973, Rodríguez et al. 2008, 2009).

Continuing with our study of *Pluteus* in Mexico, a careful study of some Mexican collections previously reported as *P. aurantiorugosus* revealed that some specimens represent a new species. Using morphological and molecular characters, this new species, *Pluteus nevadensis*, is described and reported from subtropical and pine forests in the states of Guerrero and Jalisco. Based on the infrageneric classification used by Singer (1986), which is corroborated with phylogenetic analyses of the internal transcribed spacer (ITS) of rDNA sequence data (Rodríguez et al. 2009), *P. nevadensis* is included in *Pluteus* section *Celluloderma* Fayod.

Material and methods

Morphology

Micromorphological observations were made from sections of the basidiomata mounted in 3% KOH. The terms for the descriptions are mainly those of Vellinga (1998) and in some cases those of Largent et al. (1977). Basidiospores shape was determined according to the Q (length-width ratio) (Bas 1969) of at least 20 mature and randomly selected basidiospores. The length of basidia measurements includes sterigmata. Illustrations were made with the aid of a drawing tube. The herbaria and author abbreviations follow Holmgren et al. (1990) and Kirk & Ansell (1992), respectively.

DNA extraction

Total genomic DNA was extracted from herbarium specimens following the protocol described in Aljanabi & Martinez (1997) with some modifications (Torres-Torres et al. 2009). Pellet DNA was resuspended in 30–80 µl of TE. The raw DNA was then diluted 1:2 in MilliQ water to reduce pigment concentration.

PCR amplification

The internal transcribed spacer (ITS), containing the ITS1, 5.8S and ITS2 regions of rDNA, was amplified by the polymerase chain reaction (PCR), using the pair primers ITS1F-ITS4 to amplify the entire ITS (Vilgalys & Hester 1990) or ITS5-ITS5.8S to amplify the ITS1 and ITS5.8SR-ITS4S to amplify the ITS2 (Gardes & Bruns 1993, Kretzer et al. 1996). The PCR reaction volumes were adjusted to 25 µL, consisting of 16.9 µL of MilliQ water, 2.4 µL of 10X reaction buffer (100 µM Tris, 500 µM KCl), 1.2 µL MgCl₂ (Applied Biosystems), 1.2 µL of 5 mM dNTPs, 0.1 µL of Taq DNA polymerase 5U/µL (Applied Biosystems), 0.5 µL of each 10 µM primer, 1.2 µL of BSA (bovine serum albumine) (New England Bio Labs), and 1 µL of DNA template.

PCR amplifications were performed in a MJ Research PTC 200 thermocycler as described by Rodríguez et al. (2009). Amplification from ITS region was confirmed under UV light using 1.5% agarose (NuSieve, FMC Bioproducts) gel electrophoresis in the presence of ethidium bromide. PCR products were purified with GFX[™] purification kit (Amersham Biosciences) according to the instructions provided.

Sequencing

Sequencing reactions were performed with BigDye[™] Terminator v3.1 Cycle Sequencing (Applied Biosystems) following the manufacturer's protocols with the same primers as those used in the PCR. Sequencing reactions were purified with AutoSeq[™] G-50 column (Amersham Biosciences) with 18 µL of formamide being added. Sequences were obtained by capillary electrophoresis on an ABI-Prism 310 Genetic Analyzer (Applied Biosystems). Three new sequences were generated, thirteen were from Rodríguez et al. (2009) and four were retrieved from GenBank. New sequences were deposited in GenBank with accessions numbers GU551941-GU551943 (TABLE 1). Resulting chromatograms were edited using Chromas 1.45 (McCarthy 1996–1998) and manually corrected when necessary. The assembly of the sequence fragments and the alignment of all sequences were carried out using MacClade 4.0 (Maddison & Maddison 2000).

Molecular analyses

One dataset was prepared based on 20 ITS rDNA sequences of 17 taxa: 15 sequences from 12 *Pluteus* species, one *Volvariella*, one *Leucoagaricus* and three *Entoloma* taxa (TABLE 1). Phylogenetic trees were inferred with PAUP* 4.0b10 (Altivec) (Swofford

TABLE 1. Species used in the phylogenetic analysis.

DNA CODE	SPECIES	Origin	Collector, number (herbarium), collection date	GenBank accession
113	<i>P. albotipitatus</i> var. <i>poliobasis</i> Singer	Mexico	O. Rodríguez 1545 (IBUG), 2006	FJ375244 ^a
160	<i>P. aurantiorugosus</i> (Trog) Sacc.	Spain	J.C. Zamora s.n (AH), 2001	FJ375248 ^a
6	<i>P. cervinus</i> (Schaeff.) P. Kumm.	Mexico	L. Guzmán-Dávalos 3513 (IBUG), 1986	FJ375241 ^a
242	<i>P. diverticulatus</i> Corriol	France	0092579 (holotype, PC), 1950	FJ375247 ^a
58	<i>P. horakianus</i> Rodr.-Alcánt.	Mexico	L. Guzmán-Dávalos 7488 (IBUG), 1998	FJ375250 ^a
60	<i>P. horakianus</i>	Mexico	L. Guzmán-Dávalos 7271 (holotype, IBUG), 1998	FJ375251 ^a
65	<i>P. nevadensis</i> Rodr.-Alcánt.	Mexico	V. Calderón s.n. (FCME-13128), 1984	GU551941
67	<i>P. nevadensis</i>	Mexico	O. Vargas 525 (holotype, IBUG), 1991	GU551942
114	<i>P. nigrolineatus</i> Murrill	Mexico	O. Rodríguez 1548 (IBUG), 1996	FJ375245 ^a
222	<i>P. pellitus</i> (Pers.) P. Kumm.	Mexico	J. García 9934 (IBUG), 1996	FJ375243 ^a
100	<i>P. petasatus</i> (Fr.) Gillet	Mexico	O. Rodríguez 2587 (IBUG), 2004	FJ375242 ^a
236	<i>P. pulverulentus</i> Murrill	West Indies	W.E. Broadway (holotype, NY), 1905	GU551943
119	<i>P. romellii</i> (Britzelm.) Lapl.	Mexico	O. Rodríguez 1565 (IBUG), 1996	FJ375246 ^a
85	<i>P. thomsonii</i> (Berk. & Broome) Dennis	France	95091602	FJ375252 ^a
155	<i>P. thomsonii</i>	Spain	F. Pardo s.n. (AH), 2001	FJ375253 ^a
GB	<i>Leucoagaricus sinicus</i> (J.Z. Ying) Zhu L. Yang	GB		DQ182505 ^b
GB	<i>Entoloma bloxamii</i> (Berk. & Broome) Sacc.	GB		EF530938 ^c
GB	<i>Entoloma nitidum</i> Quéł.	GB		AY228340 ^d
GB	<i>Entoloma sericeum</i> Quéł.	GB		AF357020 ^e
176	<i>Volvariella gloiocephala</i> (DC.) Boekhout & Enderle	USA	L. Guzmán-Dávalos 8444 (IBUG), 2000	FJ375254 ^a

^a Rodríguez et al. (2009); ^b From Matheny & Hibbett in 2005; ^c From Denis et al. in 2007;

^d From Acorn et al. in 2003; ^e From Hofstetter et al. in 2002.

2000) and were rooted with species of *Volvariella*, *Leucoagaricus* and *Entoloma*. Branch-and-bound searches were performed using the criterion of maximum parsimony with furthest addition sequence, branches collapsed if maximum branch length is zero, only minimal trees were kept, and MulTrees option in effect. Gaps were treated as missing characters. Starting trees were obtained via stepwise addition. Relative branch support was estimated with 1000 bootstrap replications (Felsenstein 1985) with the same parameters previously mentioned. The initial dataset included 785 characters. For the parsimony analysis, 443 sites at both ends of the sequences and ambiguous regions were excluded. The parsimony tree scores, including tree length and consistency, retention, rescaled consistency and homoplasy indices (CI, RI, RC and HI) excluding uninformative characters, were calculated. Additionally, the percentage of sites (base pairs) differing between sequences of *P. nevadensis* and both *P. aurantiorugosus* and *P. horakianus* sequences was obtained.

Results

Description of the species

Pluteus nevadensis Rodr.-Alcánt., sp. nov.

FIGS. 1–8

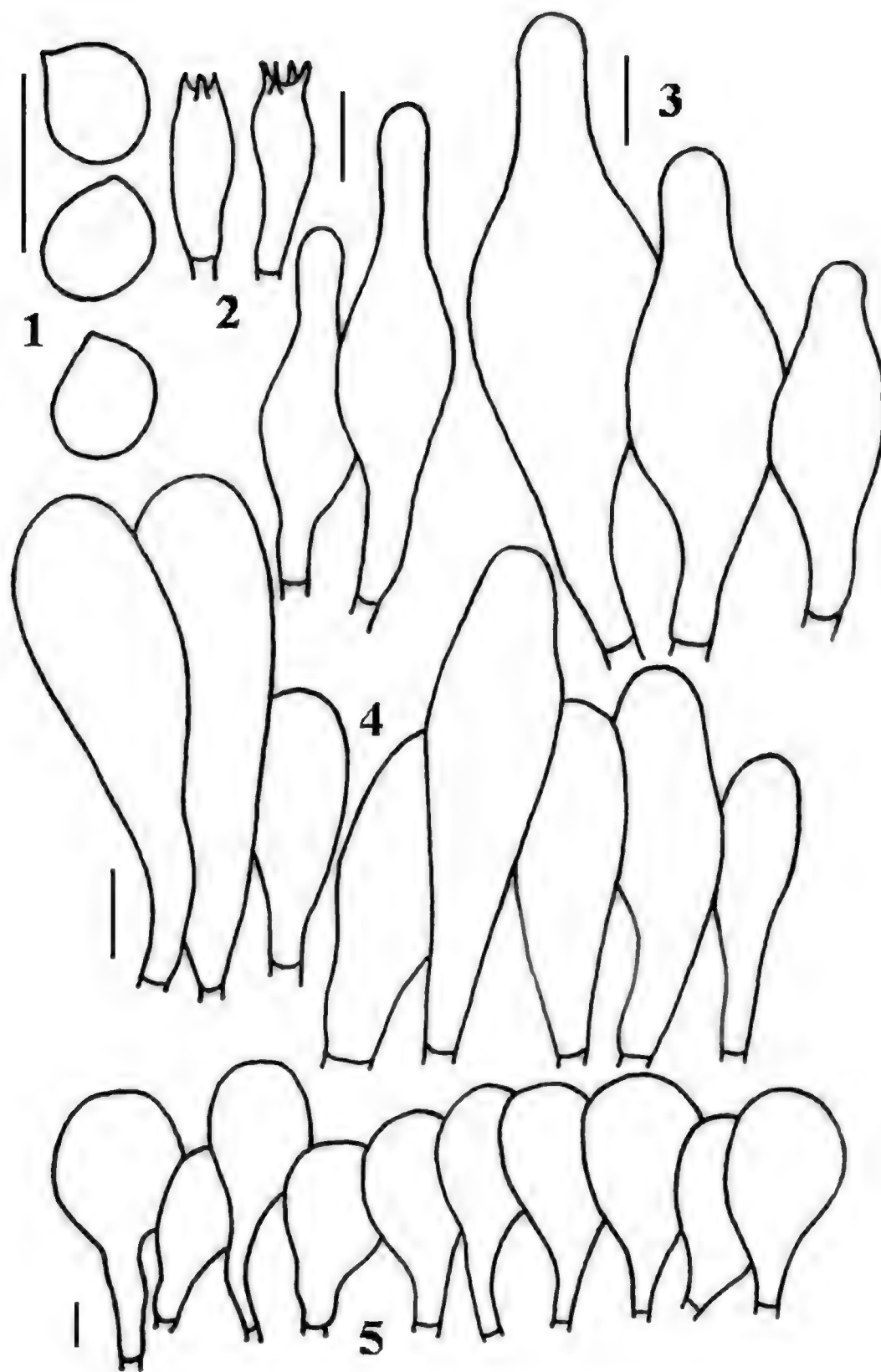
MYCOBANK MB515446

Pileus 15–38 mm *latus*, *primo conic vel campanulatus*, *dein plano-convexus*, *umbonatus*, *rugulosus vel levis ad discum*, *deflexus*, *erosus vel planus marginem rubroaurantiacus vel brunneoruber*, *siccus vel humidus*. *Lamellae liberae*, *latus vel ventricosae*, *primo albus vel albidus*, *dein salmonaeus-roseus*, *ad aciem floccosus vel fimbriatus*, *albidus*. *Stipes* 6–45 × 2–6 mm, *cylindricus*, *aequalis*, *curvatus*, *flavus vel flavobrunneus ad apex aurantiacus obscure vel aurantiacus tinctus basalis*, *albidus*, *cottoneus-strigae mycelium*, *levis vel fibrillosus*, *sericeus*, *siccus*. *Caro* 1mm, *albidula ad pileus vel flavobrunneus vel aureus*. *Odor saporque nulli*. *Basidiosporae* 5–6.5(–8) × 4.5–6.5 µm, *late ellipsoideis vel ellipsoideis*, *rarus globosus*. *Basidia* 22–29 × 6.5–7.5 µm, *clavata*, *4-sporigera*, *defibulata*. *Cheilocystidia* (24–)32–52(–61) × (8–)10–18.5(–24) µm, *clavata vel angustus clavata*, *utriformis*, *subcylindricus*, *obovatus*, *hyalina*. *Pleurocystidia* 42–75(–82) × 12–24(–27.5) µm, *polymorphica*, *lageniformia*, *brevicollis vel elongatus*, *subfusiformia vel subutriformis*, *hyalina*. *Caulocystidia nulla*. *Pileipellis e epithelium cellulis clavatis vel sphaeropedunculate formantibus*, 26–60 × 14–31 µm, *hyalina*. *Fibulae nullae*. *Habitatio ad lignum putridum in silvis mixtis* (Pinus, Quercus).

HOLOTYPE: Mexico, Jalisco: Municipality of Zapotlán el Grande, Nevado de Colima, El Floripondio 2100 m, 10.VIII.1991, O. Vargas 525 (IBUG).

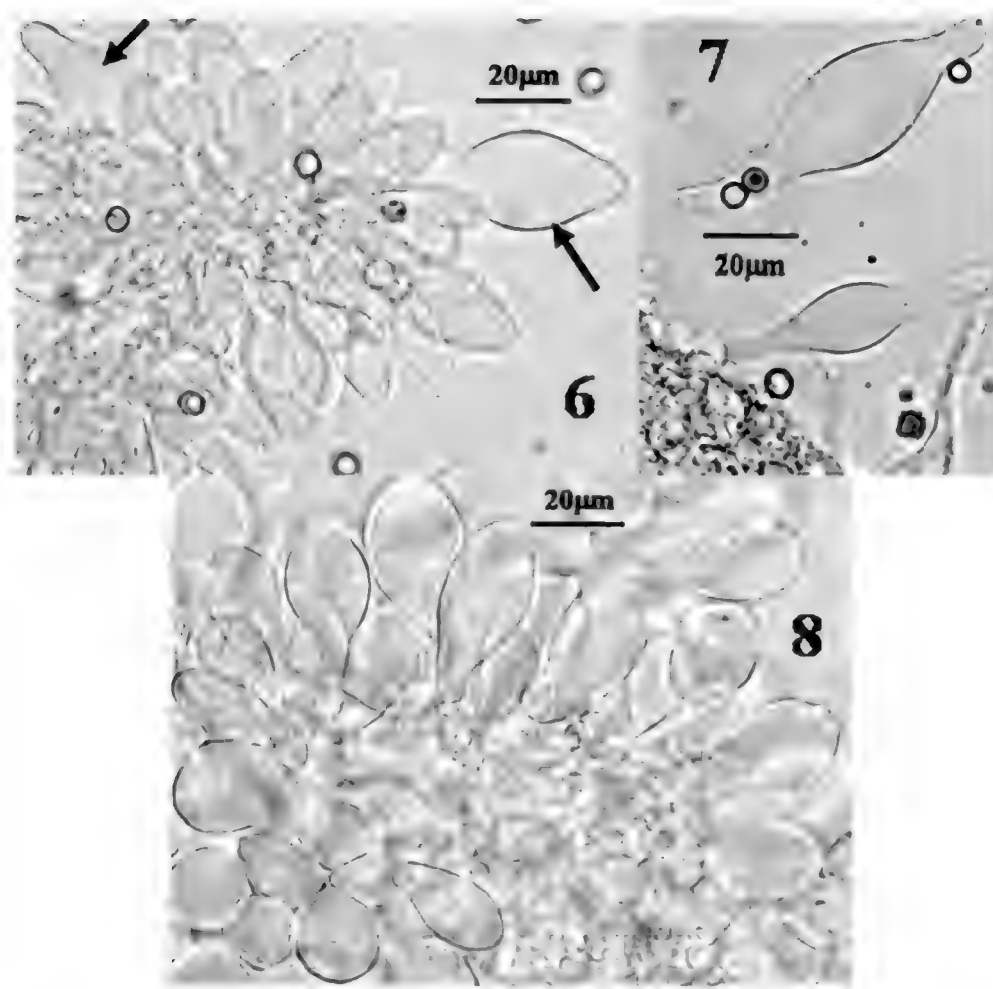
ETYMOLOGY – *nevadensis*. Named after the mountain where the type material was collected.

PILEUS 15–38 mm broad, conic when young, campanulate to convex or plane-convex when mature, umbonate; margin decurved, even or slightly eroded; surface dry to moist, rugulose towards the margin, with the disk rugose to smooth; sometimes white-yellowish context underneath the cuticle is visible; red-orange to reddish-orange. **LAMELLAE** free, crowded, broad to ventricose, white or whitish when young to salmon-pinkish in age; edge floccose or



FIGS. 1–5: *Pluteus nevadensis* (Holotype),
1: basidiospores ($\times 2000$), 2: basidia ($\times 1000$), 3: pleurocystidia ($\times 1000$),
4: cheilocystidia ($\times 1000$), 5: pileipellis ($\times 500$).

fimbriate, whitish. STIPE 6–45 \times 2–6 mm, central, equal, glabrous to slightly fibrillose, silky, hollow, yellow or yellowish at the apex, deep orange or with orange tinges towards the base; with cottony-strigose, whitish mycelium at the



FIGS. 6–8: *Pluteus nevadensis*,
6: cheilocystidia with two pleurocystidia, 7: pleurocystidia,
8: elements of pileipellis.

base. PILEUS CONTEXT 1 mm thick or more at the disk, fleshy, whitish. STIPE CONTEXT yellowish or yellow gold. SMELL AND TASTE not distinctive.

BASIDIOSPORES $5.5\text{--}7(-8) \times 4.5\text{--}6.5\text{ }\mu\text{m}$, $Q = (1\text{--})1.09\text{--}1.2$ ($L^m = 6.1\text{ }\mu\text{m}$, $W^m = 5.2\text{ }\mu\text{m}$), subglobose to broadly ellipsoid, rarely globose, smooth, wall thin to slightly thickened, subhyaline. BASIDIA $22\text{--}29(-36) \times 6.5\text{--}7.5\text{ }\mu\text{m}$ (including sterigmata), clavate, 4-spored, with refringent content, hyaline. PLEUROCYSTIDIA $(38.5\text{--})41.8\text{--}75(-81.8) \times 11.8\text{--}24(-27.5)\text{ }\mu\text{m}$, frequent, scattered, lageniform with short or elongated neck, some subfusiform or subutriform, thin-walled, hyaline. CHEILOCYSTIDIA $(24\text{--})32\text{--}55(-61) \times (8\text{--})10\text{--}18.5(-24)\text{ }\mu\text{m}$, crowded, clavate to narrowly clavate, some utriform, subcylindrical or obovoid, thin-walled, hyaline. LAMELLAR TRAMA convergent PILEIPELLIS an epithelium with elements $25.6\text{--}60 \times 13.6\text{--}31.2\text{ }\mu\text{m}$, clavate or sphaeropedunculate, generally with a long pedicel, wall thin or slightly thickened, hyaline. OLEIFEROUS HYPHAE and CLAMP CONNECTIONS absent.

MATERIAL EXAMINED – MEXICO: GUERRERO, Municipality of Chilpancingo, Cerro Palo Hueco, Omiltemi, 14.VII.1984, V. Calderón s.n. (FCME-13128). JALISCO: Municipality of Zapotlán el Grande, Nevado de Colima, El Floripondio, 23.VII.1988, L. Guzmán-Dávalos 4261 (IBUG), 10.VIII.1991, O. Vargas 525 (holotypus, IBUG).

Molecular analyses

A Branch-and-Bound search of the ITS rDNA sequence data generated four most parsimonious trees with a tree length of 247 steps. Of the 342 sites considered for the analysis, 54 were parsimony informative. Excluding uninformative characters CI = 0.555, RI = 0.7478, RC = 0.490 and HI = 0.445. Figure 9 shows one of the trees, which has the same topology of the other three, except in the placement of *P. pulverulentus*. This species always was placed within section *Celluloderma*, but its position is not resolved in the strict consensus tree. The bootstrap support for the clades is from 55 to 100%, except for one clade that is below 50%. *Pluteus nevadensis* is placed in the clade representing section *Celluloderma* along with the morphologically similar species *P. aurantiorugosus*, but *P. nevadensis* has a sister relationship with *P. horakianus* in a different subclade.

The analysis of the ITS region shows that the percentage of sites (base pairs) differing between *P. nevadensis* and both *P. horakianus* and *P. aurantiorugosus* are 7.6% and 14.3%, respectively.

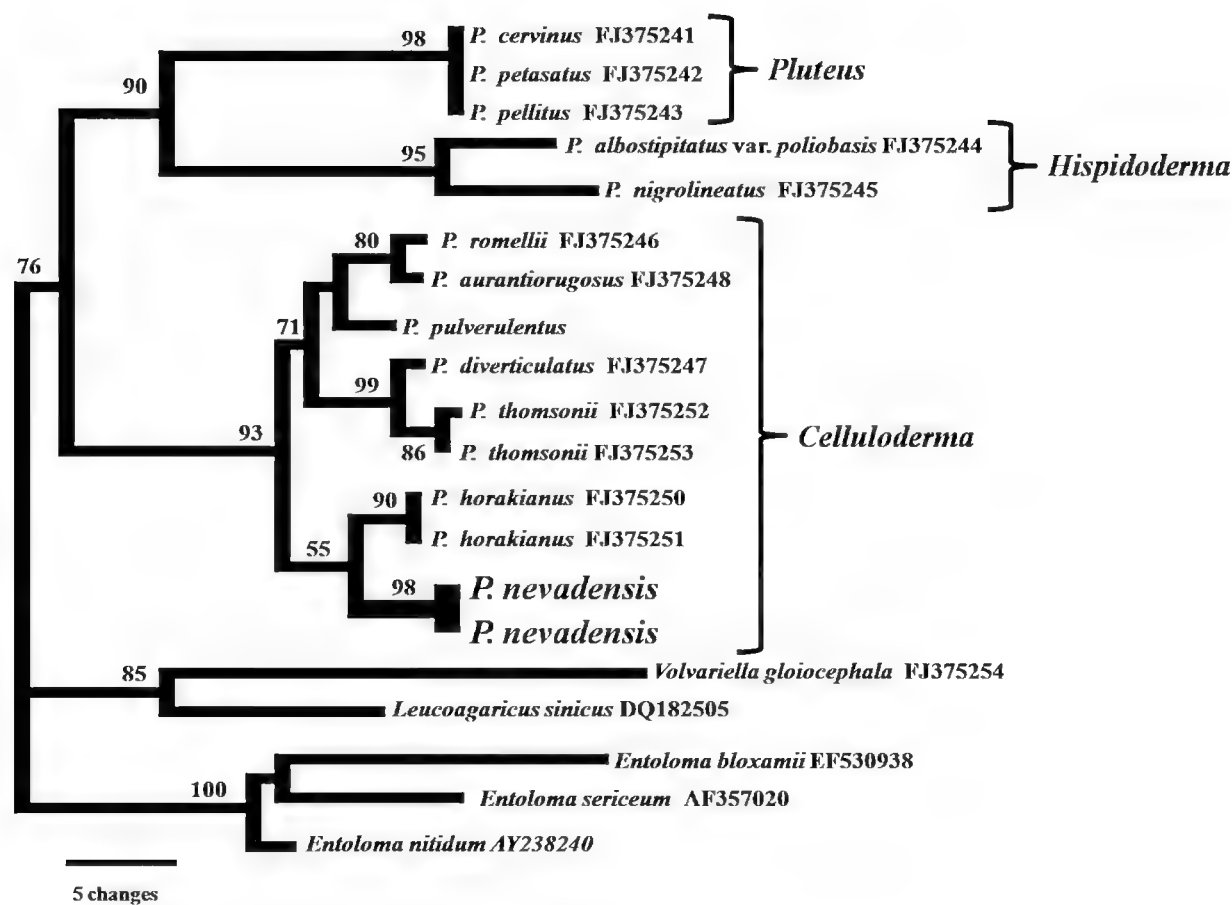


FIG. 9 One of the four phylograms resulting from a branch-and-bound search, of 12 species (15 samples) of *Pluteus*, and five outgroups, based on ITS rDNA sequence data. Tree length = 247 steps, parsimony informative characters = 54, CI excluding uninformative characters = 0.555, RI = 0.7478, RC = 0.490. Bootstrap values > 50% obtained from a branch-and-bound search with 1000 replicates are given above each branch.

Discussion

The Mexican collections are macromorphologically similar to *Pluteus aurantiorugosus*, so much so that all of the studied specimens (CALDERÓN S.N., GUZMÁN-DÁVALOS 4261, VARGAS 525) were previously recorded as this species (Cifuentes et al. 1989, Rodríguez & Guzmán-Dávalos 2001). *Pluteus aurantiorugosus* is the most similar taxon because of the scarlet, orange to red-orange pileus, the yellow to orange stipe, and the fimbriate and whitish lamellar margin. Micromorphologically, *P. aurantiorugosus* has a percentage of basidiospores that are oblong, cystidial shapes that are variable from clavate, broadly clavate to subfusiform and pileipellis elements that are typically globose with or without pigment. *Pluteus nevadensis* is distinguished by the lack of oblong basidiospores, the lageniform pleurocystidia and narrowly clavate cheilocystidia that are larger and more slender than those observed in *P. aurantiorugosus*, and by the more typically clavate pileipellis elements without pigment.

Pluteus nevadensis and *P. horakianus* are also morphologically similar fungi in the fragile basidiome, red pileus, and by the form of the pleuro- and cheilocystidia. However, *P. horakianus* is distinguished by the orange-reddish lamellar edges, the red stipe, and the pigmented pileipellis elements. Other superficially similar fungi, mainly sharing basidiome coloration, are *P. aurantiopustulatus* E. Horak, *P. aurantipes* Minnis et al., *P. flammipes* E. Horak, *P. laetifrons* (Berk. & M.A. Curtis) Sacc., and *P. laetus* Singer. Micromorphological characters such as a lack of pleurocystidia, form and size of cystidia, or different type of pileipellis readily separate *P. nevadensis* from these species. Rodríguez et al. (2009) summarized these characters for species similar to *P. horakianus*.

Previously, Rodríguez et al. (2009), based upon analyses of ITS rDNA sequence data, found that *P. horakianus* represented a distinct taxon belonging to section *Celluloderma* and that it was in a different clade than *P. aurantiorugosus*. Here, a phylogenetic analysis of the ITS region data (FIG. 9) shows that *P. nevadensis* is in a sister relationship with *P. horakianus* in section *Celluloderma*. This indicates that the two species are phylogenetically very closely related and distant to other *Pluteus* species, in particular to *P. aurantiorugosus*.

Furthermore, the analysis of the ITS region shows the percentage of ITS region sites differing between *P. nevadensis* and both *P. horakianus* and *P. aurantiorugosus* to be rather large (7.6% and 14.3%, respectively). Those percentages are high values compared with 2.2 – 4.0% between *Cortinarius* species (Vila et al. 2008).

Finally, we concluded that the examined collections of the Mexican *P. nevadensis* have enough morphological and molecular differences to be considered as a distinct new species.

Acknowledgements

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Literature cited

- Aljanabi SM, Martinez I. 1997. Universal and rapid salt-extraction of high quality genomic DNA for PCR-based techniques. *Nucleic Acids Research* 25: 4692–4693.
- Bas C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. *Persoonia* 5: 285–579.
- Cifuentes J, Pérez-Ramírez L, Villegas M. 1989. Descripción de macromicetos poco estudiados en México, III. *Revista Mexicana de Micología* 5: 101–115.
- Felsenstein J. 1985. Confidence limits on phylogenies: on approach using the bootstrap. *Evolution* 39: 783–791.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes—application to the identification of mycorrhizae and rusts. *Molecular Ecology* 2: 113–118.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. *Index Herbariorum*. Part I. The herbaria of the world. 8th edn. New York Botanical Garden, New York, USA.
- Kirk PM, Ansell AE. 1992. Authors of fungal names. A list of authors of scientific names of fungi with recommended standard forms of their names, including abbreviations. *Index of Fungi Supplement*. CAB International, Kew, Surrey, England.
- Kretzer A, Li Y, Szaro T, Bruns TD. 1996. Internal transcribed spacer sequences from 38 recognized species of *Suillus sensu lato*: phylogenetic and taxonomic implications. *Mycologia* 88: 776–785.
- Largent DL, Johnson D, Watling R. 1977. How to identify mushrooms to genus I: Macroscopic features. Mad River Press, Eureka, USA.
- Liu AR, Xu T, Guo LD. 2007. Molecular and morphological description of *Pestalotiopsis hainanensis* sp. nov., a new endophyte from a tropical region of China. *Fungal Diversity* 24: 23–36.
- McCarthy C. 1996–1998. Chromas vs. 1.45 (32 bit). Queensland, Australia.
- Maddison DR, Maddison WP. 2000. *MacClade* 4. Sinauer Associates, Sunderland, USA.
- Murrill WA. 1911. The *Agaricaceae* of tropical North America—IV. *Mycologia* 3: 271–282.
- Patouillard NT. 1898. Quelques champignons récoltés au Mexique par Paul Maury. *Bulletin de la Société Mycologique de France* 14: 53–57.
- Rodríguez O, Guzmán-Dávalos L. 2001. Clave dicotómica de las especies del género *Pluteus* Fr. (*Pluteaceae*) conocidas de la Nueva Galicia y algunas áreas aledañas, México. *Acta Botánica Mexicana* 57: 23–36.
- Rodríguez O, Galván-Corona A, Villalobos-Arámbula AR, Vargas G, Guzmán-Dávalos L. 2009. *Pluteus horakianus*, a new species from Mexico, based on morphological and molecular data. *Sydowia* 61: 39–52.
- Rodríguez O, Guzmán-Dávalos L, Horak E. 2008. *Pluteus neotropicalis* (*Pluteaceae*, *Agaricales*), a new species from tropical-subtropical Mexico. *Mycotaxon* 103: 273–278.

- Singer R. 1973. Diagnoses fungorum novarum agaricalum III. Beihefte zur Sydowia 7: 1–106.
- Singer R. 1986. The *Agaricales* in modern taxonomy. Koeltz Scientific Books, Koenigstein, Germany. 4th edition.
- Swofford DL. 2000. PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, USA.
- Torres-Torres MG, Guzmán-Dávalos L y Villalobos-Arámbula AR. 2009. Metodología para la extracción de adn de material de herbario de *Ganoderma* (*Fungi*, *Basidiomycetes*). Investigación, Biodiversidad y Desarrollo 28(2): 186–189.
- Vellinga EC. 1998. Glossary. In: Bas C, Kuyper TH, Noordeloos ME, Vellinga EC (eds.). Flora Agaricina Neerlandica vol 2. Balkema, Rotterdam, The Netherlands.
- Vila J, Ortega A, Suárez-Santiago VN, Llimona X. 2008. *Cortinarius mahiquesii*, a new subhypogeous species from Catalonia (Iberian Peninsula). Persoonia 21: 153–157.
- Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping enzymatically amplified ribosomal DNA from several *Cryptococcus* species. Journal of Bacteriology 172: 4238–4246.

Three new species of the genus *Erysiphe* (Ascomycota, Erysiphales) on legumes and some new combinations

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Abstract — The new combination *Erysiphe trifoliorum* (= *Erysiphe trifolii*) is introduced, and its former varieties *E. trifolii* var. *intermedia* and var. *desmanthi* are reassessed and raised to species rank. Furthermore, three new species of the genus *Erysiphe*, viz. *Erysiphe baptisiae* on *Baptisia australis* in Europe, *E. baptisiicola* on *Baptisia* spp. in North America and *E. sesbaniae* on *Sesbania punicea* in Argentina, South America, are described, illustrated and discussed. A key to species of *Erysiphe* on legumes allied to the new species is provided.

Key words — *Erysiphaceae*, *E. desmanthi*, *E. intermedia*, *Fabaceae*, lectotype

Introduction

Powdery mildews (*Erysiphales*) of the genus *Erysiphe* DC. on legumes represent one of the taxonomically most complicated groups within this genus. There

is a wide range of species on legumes with unbranched, irregularly branched to dichotomously branched chasmothecial appendages that are intermediate between those of the classical genera, *Erysiphe* and *Microsphaera* Lév. (Braun 1987, Heluta 1998), now treated as sections of *Erysiphe* emend. U. Braun & S. Takam. (Braun & Takamatsu 2000). The existence of such intermediate taxa questioned the justification of the classical discrimination between *Erysiphe* and *Microsphaera*. Phylogenetic hypotheses based on molecular sequence analyses (Saenz & Taylor 1999, Mori et al. 2000) supported the assumption that a separation of *Erysiphe* and *Microsphaera* is not tenable, which led to the merging of the two genera (Braun & Takamatsu 2000, Braun et al. 2002). In this work, the nomenclature and taxonomy of the *Erysiphe trifolii* complex are reassessed and revised. Furthermore, three new species on legumes belonging to the morphologically intermediate taxa described above have been found. They are described and discussed, and a key to them and allied species is provided.

Materials and methods

Fruiting bodies were mounted in distilled water and examined for description by means of standard light microscopy (Olympus BX 50, Hamburg, Germany) using oil immersion (bright field and phase contrast), but without any staining. Anamorphs were mounted in lactic acid, gently heated and stained with cotton blue. Thirty measurements ($\times 1000$ magnification) of conidia and other structures were made. The extremes are given in parentheses. The collections examined are deposited in the herbaria BPI, HAL, LPS and STR (abbreviations according to Holmgren et al. 1990).

Taxonomy

1. Reassessment of nomenclature and taxonomy of *Erysiphe trifolii*

Erysiphe trifolii is a common and widespread powdery mildew on a wide range of legumes, and it is well characterized and distinguished from *E. pisi* DC. by its very long, non-mycelioid chasmothecial appendages (Braun 1987, 1995; Braun & Takamatsu 2000). The appendages are usually unbranched, but in fully mature samples some apices may become 1–2(–3) times dichotomously branched with straight ultimate tips, which renders this species a morphologically intermediate taxon between the former classical concepts of *Erysiphe* (now *Erysiphe* sect. *Erysiphe*) and *Microsphaera* (now *Erysiphe* sect. *Microsphaera* (Lév.) U. Braun & Shishkoff). Recently, original material of powdery mildew species described by Wallroth (1819a,b) under *Alphitomorpha* Wallr. has been re-examined and considered, in some cases, for lectotypification purposes. Type material, designated below, of *Alphitomorpha trifoliorum*, a name that is older than *E. trifolii*, proved to be identical with the current concept of the latter

species, i.e. *A. trifoliorum* has priority and must be reallocated to *Erysiphe*. The epithets “*trifoliorum*” and “*trifolii*” are not confusable. Also, the former concept of *E. trifolii* is morphologically heterogeneous and includes several taxa that have to be recognized as distinct from *E. trifolii*. Two morphologically well-discriminated varieties have been previously described (Braun 1984, 1985, 1987, 1995), and these are herein, in a first step, raised to species rank. *E. trifolii* s. str., now *E. trifoliorum*, without its varieties is still a complex species with wide host range and considerable morphological variability. Braun (1987) listed names of various species as synonyms of *E. trifolii*, e.g. *Erysiphe robiniae* Grev. and *Microsphaera caraganae* Magnus. It is now necessary in a subsequent publication to re-examine and reassess the whole complex in a second step.

***Erysiphe trifoliorum* (Wallr.) U. Braun, comb. nov.**

MYCOBANK, MB 516541

BAS.: *Alphitomorpha trifoliorum* Wallr., Ann. Wetterauischen
Ges. Gesamte Naturk. 4: 238, 1819.

= *Erysiphe trifolii* Grev., Fl. edin.: 459, 1824.

= *Microsphaera trifolii* (Grev.) U. Braun, Nova Hedwigia 34: 685, 1981.

Lectotype of *A. trifoliorum* (designated here): on *Trifolium medium* L. (= *T. flexuosum* Jacq.), GERMANY, without any further data, herb. Wallroth (STR).

NOTES: Wallroth (1819b) introduced the name *A. trifoliorum*, i.e. he undoubtedly intended to and described a new species of powdery mildew for *Trifolium* spp. The lectotype is the only collection in Wallroth's herbarium deposited as *A. trifoliorum* [on *Trifolium medium* (= *T. flexuosum*)], i.e. a host species mentioned by Wallroth (1819b) in the original description, and we presume it is part of the original material. *A. trifoliorum* is the oldest valid name for this species. The morphological characteristics of the lectotype collection of *A. trifoliorum* agree well with those of other collections of *E. trifoliorum* on *Trifolium* spp.: Chasmothecia 90–130 µm diam., with 8–20 appendages, 2–5 times as long as the chasmothecial diam., with few septa, apex mostly simple, rarely dichotomously branched, asci 4–8, 50–70 × 25–45 µm, 3–5-spored, ascospores 19–24 × 10–14 µm.

***Erysiphe intermedia* (U. Braun) U. Braun, comb. et stat. nov.**

MYCOBANK, MB 516542

BAS.: *Microsphaera trifolii* var. *intermedia* U. Braun,
Zentralbl. Mikrobiol. 140: 416, 1985.

= *Erysiphe trifolii* var. *intermedia* (U. Braun) U. Braun &
S. Takam., Schlechtendalia 4: 15, 2000.

HOLOTYPE: on *Lupinus perennis* L., USA, Massachusetts, Mouson, Aug. 1883, A.B. Seymour, Rabenh., Fungi Eur. Exs. 3243a (HAL). Isotypes: Rabenh., Fungi Eur. Exs. 3243a. PARATYPES: on *Lupinus perennis*, USA, New Jersey, Jamesburg, Jul. 1889, B.D. Halsted, Ellis & Everh., N. Amer. Fungi 2338 (FH); USA, Ohio, Toledo, 21 Jul. 1900, F.D. Kelsey, Vestergr., Micromyc. Rar. Sel. Praec. Scand. 664 (FH).

NOTES: This species is confined to hosts of the genus *Lupinus* in North America and Europe. It is easily distinguishable from *E. trifoliorum* by having 0–1-septate, colorless chasmothecial appendages with a distinct tendency to turn towards one direction, as for instance in *Erysiphe astragali* DC. and *E. baeumleri* (Magnus) U. Braun & S. Takam. (Braun 1987, 1995). The appendages in *E. trifoliorum* are horizontally spread, 0–6-septate and pigmented below the septa.

***Erysiphe desmanthi* (U. Braun) U. Braun, comb. et stat. nov.**

MYCOBANK, MB 516543

BAS.: *Microsphaera trifolii* var. *desmanthi* U. Braun, Mycotaxon 19: 375, 1984.

= *Erysiphe trifolii* var. *desmanthi* (U. Braun) U. Braun & S. Takam., Schlechtendalia 4: 15, 2000.

HOLOTYPE: on *Desmanthus illinoensis* (Michx.) MacMill. ex B.L. Rob. & Fernald (= *D. brachylobus* Benth.), USA, Missouri, St. Louis, Oct. 1886, herb. Trelease (FH).

NOTES: *E. desmanthi* is an endemic North American species well-distinguished from *E. trifoliorum* by having much smaller, usually caulicolous chasmothecia, 70–90(–105) µm diam., and evidently verrucose appendages (Braun 1987).

2. A new species of *Erysiphe* on *Baptisia australis* in Europe

***Erysiphe baptisiae* U. Braun & J. Kruse, sp. nov.**

FIG. 1

MYCOBANK, MB 516544

Erysiphes intermediae similis, sed appendicibus chasmotheciorum horizontaliter effusis, cellulis basalibus conidiophorum saepe curvatis vel sinuosis.

ETYMOLOGY: derived from the host genus.

TYPE: GERMANY. NIEDERSACHSEN, Hannover, Herrenhausen/Leinhausen, Vinnhorster Weg, Schulbiologiezentrum, on *Baptisia australis* (L.) R. Br. (*Fabaceae*), 5 Oct. 2009, J. Kruse (HAL 2337 F, holotype).

MYCELIUM amphigenous, in grayish white patches or effuse, often covering the entire leaf surface, thin, persistent; hyphae branched, usually straight to somewhat sinuous, 3–7 µm wide, septate, hyaline, thin-walled, smooth or almost so. APPRESSORIA solitary, 3–7 µm diam., lobed. CONIDIOPHORES arising from superficial hyphal mother cells, terminal to lateral, almost in the middle of the mother cell or toward one end, erect, straight, up to about 80 µm long (without conidia), foot-cells 15–35 × 5–8 µm, cylindrical, straight to mostly somewhat curved to distinctly sinuous, followed by 1–2 shorter cells, about 10–30 µm long. CONIDIA formed singly, primary conidia ellipsoid-ovoid, secondary conidia ellipsoid-cylindrical to almost doliiform, 22–35 × 12–16 µm, length/width ratio usually 1.8–2.5, ends rounded to truncate. CHASMOTHECIA scattered to gregarious, 80–120 µm diam., subglobose; peridium cells irregularly polygonal, 10–25(–30) µm diam., walls of the cells up to about 2 µm thick. APPENDAGES 6–15(–20), ± equatorial, flexuous, straight, curved to sinuous,

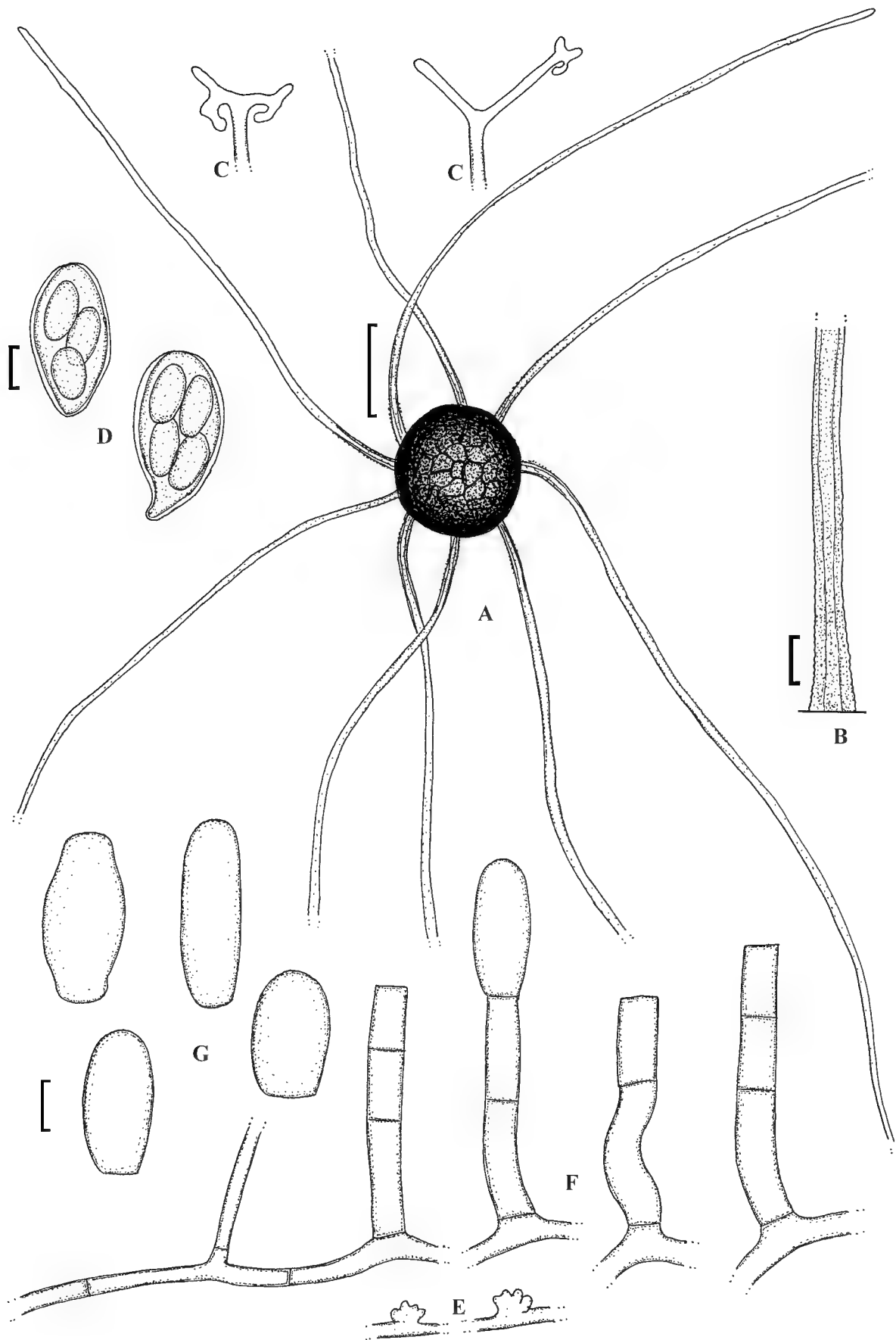


FIG. 1. *Erysiphe baptisiae* (based on type material).
 A. Chasmothecium. B. Appendage. C. Branched tips of appendages (from Eliade 1990, as *Microsphaera rayssiae*). D. Asci. E. Appressoria. F. Conidiophores. G. Conidia.
 Scale bars = 100 µm (A), 10 µm (B–G). U. Braun del.

more or less horizontally spread, not turning towards one direction, apex usually unbranched, rarely 1–2 times dichotomously branched in fully mature samples, ultimate tips straight to somewhat curved, 4–10 times as long as the chasmothecial diam. (up to about 800 µm long), 3–8 µm wide, width somewhat decreasing from base to top, aseptate, hyaline, thick-walled at the base, up to 3 µm, becoming gradually thinner towards the tip, verruculose towards the base, smooth above. ASCI 3–8 per chasmothecium, obovoid to saccate, $45\text{--}70 \times 25\text{--}35$ µm, sessile to short-stalked, wall thin, up to 1.5 µm, terminal oculus indistinct, 3–5-spored, ascospores ellipsoid-ovoid, $14\text{--}23 \times 10\text{--}14$ µm, colorless.

COMMENTS: European powdery mildew on *Baptisia australis* has previously been referred to as *Erysiphe rayssiae* (Mayor) U. Braun & S. Takam. [= *Microsphaera rayssiae* Mayor] (Mayor 1968, Eliade 1990). *Erysiphe rayssiae* on *Spartium* [Fabaceae, Genisteae] is quite distinct from *E. baptisiae* on *Baptisia* [Fabaceae, Thermopsidae] by having straight, cylindrical conidiophores and very irregularly shaped, mycelioid, strongly geniculate-sinuuous chasmothecial appendages with frequently branched apices. *Erysiphe baptisiae* belongs to the *E. trifoliorum* complex, characterized by chasmothecia with very long, but usually unbranched appendages. Eliade's (1990) description agrees very well with *E. baptisiae*, but she described and illustrated the occurrence of terminally branched appendages. However, material on *Baptisia* from Romania and Switzerland was not available for re-examination. The foot-cells of the conidiophores in *E. intermedia* and *E. trifoliorum* are cylindrical, usually straight, only occasionally slightly curved or flexuous. The appendages in *E. trifoliorum* are 0–6-septate and pigmented below the septa. The long appendages in *E. intermedia* have an obvious tendency to turn towards one direction, as in *E. astragali* and *E. baeumleri*. The appendages in the latter two species are often dichotomously branched. *Erysiphe* on *Baptisia* spp. is known from North America and was previously identified as *E. polygoni* DC., *E. communis* (Wallr.) Schltdl. and *E. martii* Lév. Several collections deposited at BPI have been examined, but all of them proved to belong to another species, one described below, that is morphologically closer to *E. pisi*.

3. A new species of *Erysiphe* on *Baptisia* spp. in North America

Erysiphe baptisiicola U. Braun, sp. nov.

FIG. 2

MYCOBANK, MB 516545

Erysiphe pisi similis, sed cellulis basalibus conidiophorum saepe curvatis vel sinuosis, conidiis angustioribus, plus minusve < 15 µm latis, appendicibus chasmotheciorum obscure pauciseptatis, parietibus basim versus incrassatis, verruculosus.

ETYMOLOGY: derived from the host genus.

TYPE: USA. CONNECTICUT, Elm City Nursery, on leaves of *Baptisia australis* (Fabaceae), Oct. 1907, G.P. Clinton (BPI 564440, holotype).

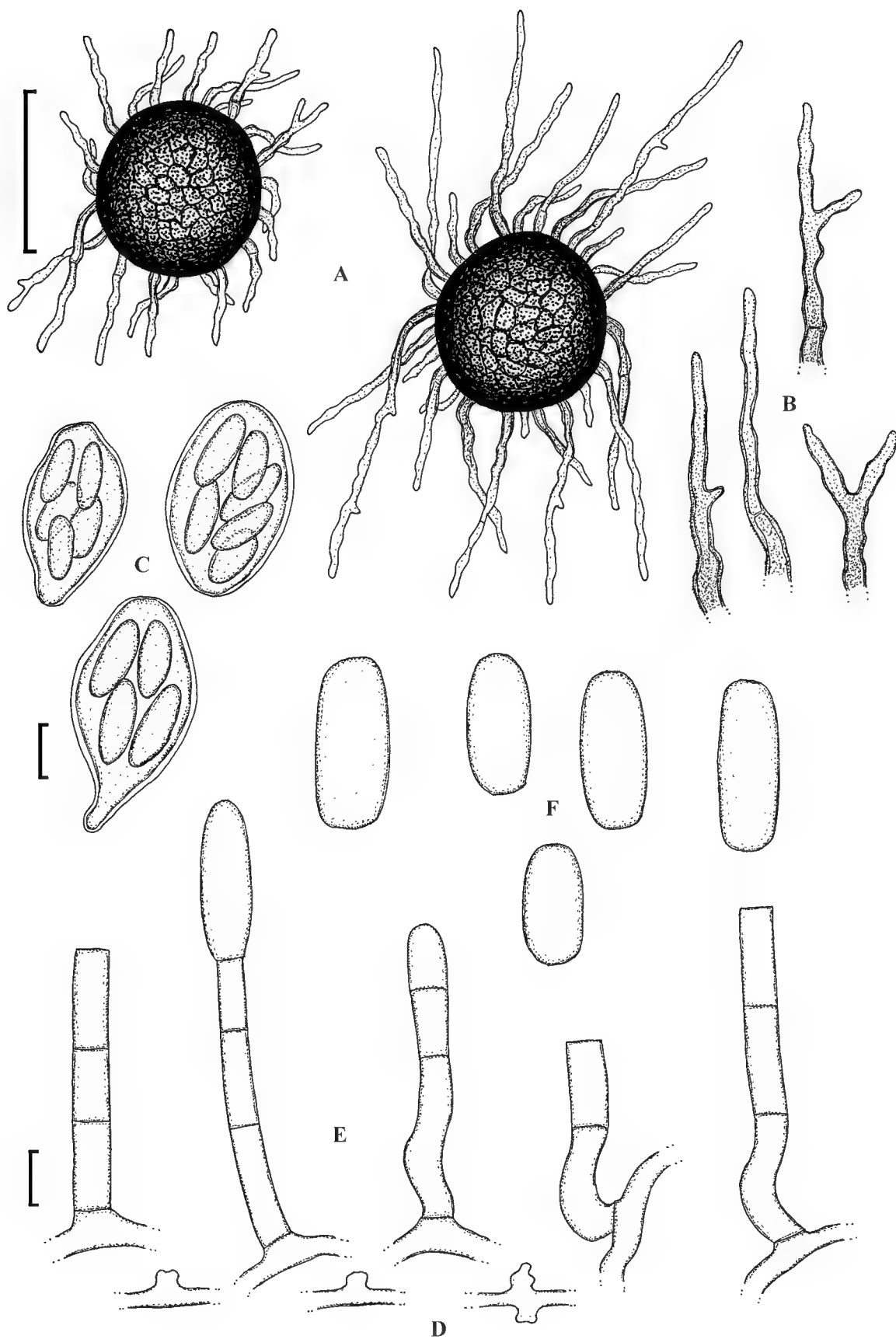


FIG. 2. *Erysiphe baptisiicola* (based on type material).
 A. Chasmothecia. B. Appendages. C. Asci. D. Appressoria. E. Conidiophores. F. Conidia.
 Scale bars = 100 μ m (A), 10 μ m (B–F). U. Braun del.

MYCELIUM amphigenous, forming dense, thin to thick, persistent patches or complete covers; hyphae branched at more or less right angle, straight to sinuous, 2–7 μm wide, septate, hyaline, thin-walled, smooth to verruculose. APPRESSORIA solitary or occasionally in opposite pairs, nipple-shaped, with crenulate outline to somewhat lobed, 2–5 μm diam. CONIDIOPHORES arising from superficial hyphal mother cells, terminal to lateral, usually somewhat towards one end of the cell, erect, up to about 90 μm long (without conidia), foot-cells 15–30 \times 6–9 μm , subcylindrical, straight to usually curved-sinuous, followed by 1–3 shorter cells, cells of about the same length or even longer. CONIDIA formed singly, narrowly ellipsoid-cylindrical, 25–38 \times 10–17 μm , on average < 15 μm wide, length/width ratio 1.6–2.5. CHASMOTHECIA scattered to gregarious, 80–120 μm diam., subglobose to depressed-globose or almost hemispherical; peridium cells irregularly polygonal, 5–20 μm diam., wall of the cells up to 2.5 μm thick. APPENDAGES numerous, equatorially arising and from the lower half, mycelioid, almost straight to usually sinuous or geniculate-sinuous, often strongly so, unbranched or occasionally irregularly branched, with short branchlets, 0.25–2 times as long as the chasmothecial diam. (up to about 220 μm), 3–9 μm wide, aseptate or only with few rather inconspicuous septa, at first hyaline, later pigmented, shorter appendages yellowish brown to medium brown throughout, longer ones brown below and paler towards the apex, tips subhyaline or hyaline, wall at first thin, later thin above and somewhat thickened towards the base, up to 2 μm thick, almost smooth to usually distinctly verruculose. ASCI 3–10, broadly ellipsoid-obovoid, saccate, 40–75 \times 25–40 μm , sessile to short-stalked, (3–)4–6(–7)-spored, ascospores ellipsoid-ovoid, 15–25 \times 8–12 μm , colorless to yellowish.

ADDITIONAL MATERIAL EXAMINED: USA. CONNECTICUT, Westville, Elm City Nursery, 29 Oct. 1907, G.P. Clinton (BPI 564441); without locality, 5 Nov. 1942, G.M. Reed (BPI 564442); MASSACHUSETTS, Wellesley, on leaves of *Baptisia tinctoria* (L.) R. Br., 14 Oct. 1884, C.E. Cummings (BPI 562107); MASSACHUSETTS, Andover, 6 Oct. 1924, E.W. Thompson (BPI 562196); NEW YORK, Rockland County, Nyack, 18 Aug. 1883, without collector (BPI 563594); PENNSYLVANIA, Westmoreland County, New Florence, 8 Sep. 1907, D.R. Sumstine (BPI 562108); without locality and date, W.G. Farlow (BPI 562107).

COMMENTS: *Erysiphe baptisiicola* is easily distinguishable from *E. baptisiae* by its much shorter, mycelioid (geniculate-sinuous), septate, pigmented chasmothecial appendages. This species belongs to the *Erysiphe pisi* complex, but it differs in having chasmothecial appendages without or with only few rather inconspicuous septa and walls that are thick-walled towards the base. Furthermore, the anamorph of *E. baptisiicola* is quite distinct by having conidiophores with curved-sinuous foot-cells and narrower conidia (foot-cells straight and conidia 24–55 \times 13.5–22 μm , on average > 15 μm wide, in *E. pisi*, see Braun 1987, 1995).

4. A new species of *Erysiphe* on *Sesbania punicea*

Erysiphe sesbaniae Wolcan & U. Braun, sp. nov.

FIG. 3

MYCOBANK, MB 516546

Erysiphe robiniicola similis, sed cellulis basalibus conidiophorum brevioribus, 20–45 × (5–)6–9(–10) µm, appendicibus chasmotheciorum ubique crassitunicatis, ascosporis anguste ellipsoideis-ovoideis, interdum apice attenuato.

ETYMOLOGY: derived from the host genus.

TYPE: ARGENTINA. BUENOS AIRES PROVINCE, La Plata, in a nursery, on leaves of young trees of *Sesbania punicea* (Cav.) Benth. (*Fabaceae*), Oct. 2009, N. Acosta (HAL 2330 F, holotype; LPS 48291, isotype).

MYCELIUM amphigenous, in white patches or effuse, often covering the entire leaf surface, thin to usually rather thick, persistent; hyphae branched, 2–7 µm wide, septate, hyaline, thin-walled, smooth to somewhat rough-walled. APPRESSORIA solitary, 3–10 µm diam., slightly to moderately lobed, occasionally almost nipple-shaped. CONIDIOPHORES arising from superficial hyphal mother cells, more or less terminal, in the middle or somewhat towards one end, erect, straight, up to about 80 µm long (without conidia), foot-cells 20–45 × (5–)6–9(–10) µm, cylindrical, usually straight, occasionally somewhat sinuous, followed by 1–2(–3) shorter cells, sometimes followed by a single cell of about the same length. CONIDIA formed singly, primary conidia ellipsoid-ovoid, secondary conidia narrowly cylindrical or ellipsoid-cylindrical, 25–40 × 10–18 µm, length/width ratio 1.9–2.9, ends rounded to subtruncate. CHASMODHECIA scattered to gregarious, (80–)100–140 µm diam., subglobose; peridium cells irregularly polygonal, 10–30 µm diam., walls of the cells up to 2 µm thick. APPENDAGES numerous, mostly about 10–15, ± equatorial and in the lower half, straight to often strongly sinuous-subgeniculate, simple, unbranched or apically irregularly to dichotomously branched, depending on age and developmental stage, 0.5–3.5 times as long as the chasmothecial diam. (up to about 350 µm long), 4–10 µm wide from base to top or somewhat narrower towards the apex, aseptate or 1–3(–4)-septate in the lower half, septa thin and often rather inconspicuous, hyaline or brown below and paler or colorless towards the apex, wall thick-walled from base to top or thinner towards the apex, up to 3 µm thick, rough-walled, often coarsely verruculose. ASCI 5–10 per chasmothecium, obovoid to saccate, 60–80 × 25–50 µm, short-stalked, wall up to 2.5 µm thick, terminal oculus relatively small, about 8–12 µm diam., (2–)3–4(–5)-spored, ascospores narrowly ellipsoid-ovoid, sometimes distinctly attenuated towards one end, (18–)20–28(–30) × 9–12 µm, colorless.

COMMENTS: *Erysiphe sesbaniae* belongs to a group of *Erysiphe* species that are characterized by having strongly sinuous-subgeniculate, thick-walled, distinctly, often coarsely verrucose chasmothecial appendages. The appendages are simple, unbranched or apically irregularly to dichotomously branched,

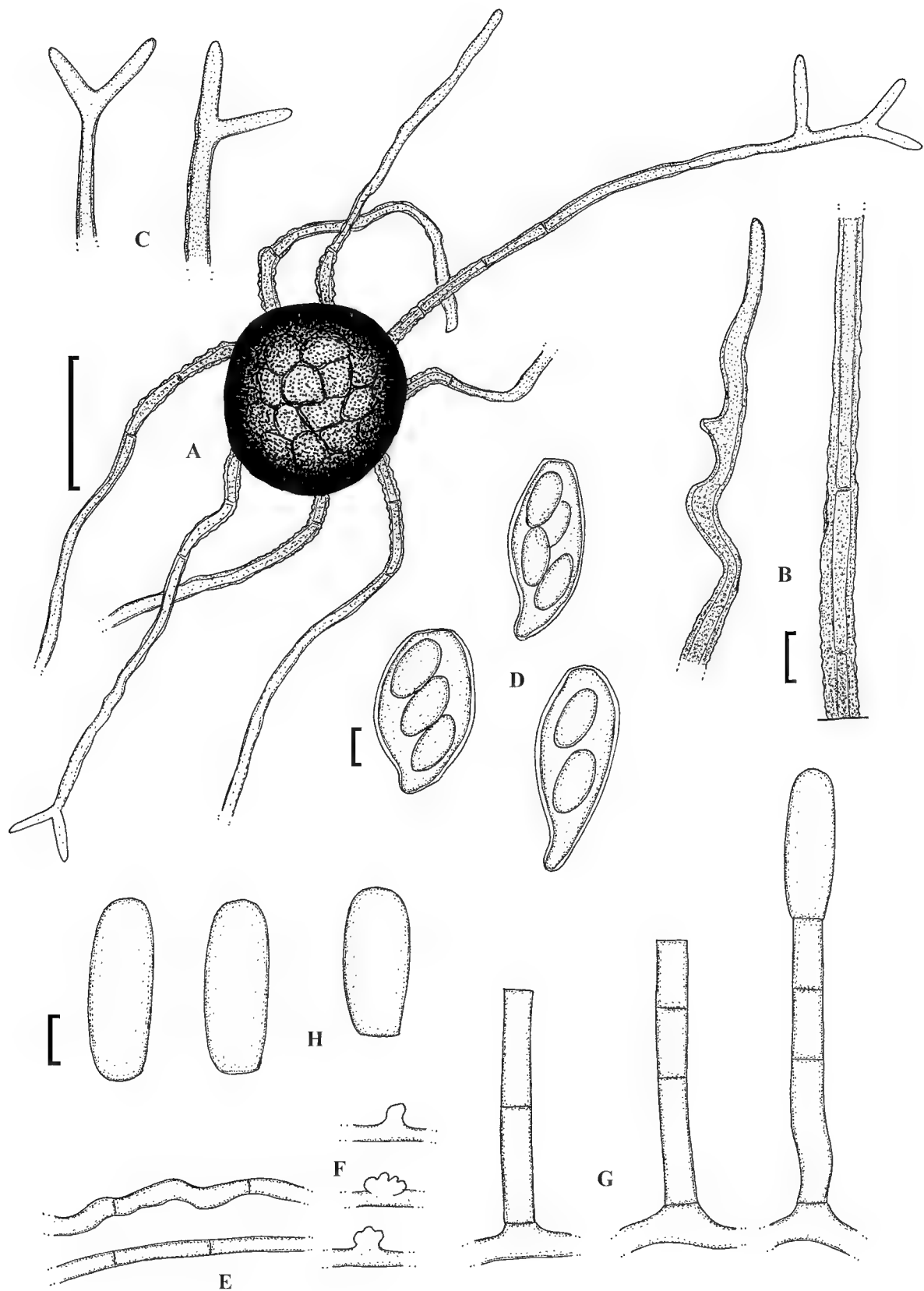


FIG. 3. *Erysiphe sesbaniae* (based on type material).
A. Chasmothecium. B. Base and apex of an appendage. C. Tips of appendages.
D. Asci. E. Hyphae. F. Appressoria. G. Conidiophores. H. Conidia.
Scale bars = 100 μ m (A), 10 μ m (B–H). U. Braun del.

depending on age and developmental stage, rendering the species concerned morphologically intermediate between *Erysiphe* sect. *Erysiphe* and *Erysiphe* sect. *Microsphaera*. The following species, almost all from Asia, belong to this group: *Erysiphe bremeri* U. Braun on *Alhagi* and *Sophora* spp.; *E. crispula* (U. Braun) U. Braun & S. Takam. on *Astragalus* (Asia and North America), *E. hedysari* (U. Braun) U. Braun & S. Takam. on *Hedysarum* spp. and *Anthyllis maura* Beck; *E. thermopsidis* R.Y. Zheng & G.Q. Chen [= *Microsphaera thermopsidis* U. Braun (= *E. shinii* U. Braun & S. Takam.)] on *Thermopsis* spp.; and *E. robiniicola* U. Braun & S. Takam. [= *Microsphaera robiniae* F.L. Tai, non *Erysiphe robiniae* Grev.] on *Robinia* spp. (Braun 1987, Braun & Takamatsu 2000, Braun et al. 2009, Liu & Braun 2009). *Erysiphe robiniicola*, known from China on *Robinia hispida* L. and *R. pseudoacacia* L., is morphologically close to *E. sesbaniae*, but it differs in having conidiophores with longer foot-cells, 30–65 µm, appendages thick-walled below and thin-walled towards the apex, and broadly ellipsoid-ovoid ascospores, 15–22 × 9–14 µm, which are never distinctly attenuated towards one end (Braun et al. 2009). *Robinia* and *Sesbania* are two related genera that cluster together in the robinoid clade [*Robinieae*] (Wojciechowski et al. 2004). There are numerous records of powdery mildew on various *Sesbania* spp. under different names, e.g. *Erysiphe communis*, *E. polygoni* and *Oidium* sp. (Amano 1987). The identity and relation of these records to *E. sesbaniae* are unclear.

5. Key to the species of the *Erysiphe bremeri* / *E. pisi* / *E. trifoliorum* complex on legumes

1. Chasmothecia only with 1–4(–7) appendages, 0(–3)-septate, apex occasionally 1(–2) times branched; on *Pueraria*, China. *E. puerariae* R.Y. Zheng & G.Q. Chen
- 1* Chasmothecia with numerous appendages 2
2. Chasmothecial appendages mycelioid (geniculate-sinuous), about 0.5–3 times as long as the chasmothecial diam., equatorially arising and from the lower half, unbranched or irregularly branched 3
- 2* Chasmothecial appendages either apically at least partly dichotomously branched and/or appendages not mycelioid, straight to flexuous, and very long, 3–10 times the chasmothecial diam. 13
3. Appendages rather short, 0.5–1(–2) times as long as the chasmothecial diam., hyaline or only faintly yellowish, 0–1(–2)-septate, thin-walled, usually curved, “spider-like;” on *Genista*, *Melilotus* and *Thermopsis*, Asia, Armenia *E. thermopsidis*
- 3* Appendages not characteristically curved, not “spider-like” 4
4. Appendages frequently irregularly branched or even branched in a coral-like manner 5
- 4* Appendages usually unbranched, only occasionally irregularly branched 6

5. Appendages frequently and strongly branched, hyaline to yellowish, aseptate or only with 1–2 inconspicuous septa; on *Lathyrus* and *Vicia* in Asia
..... *E. viciae-unijugae* (Homma) U. Braun
- 5* Appendages moderately branched, brown throughout or at least in the lower half, thin-walled, conspicuously pluriseptate; on *Lathyrus* and *Ononis*, Europe
..... *E. pisi* var. *cruchetiana* (S. Blumer) U. Braun
6. Chasmothecia large, (100–)110–185(–210) µm diam., confined to stems, appendages narrow, 3.5–7 µm wide, fairly thick-walled throughout, aseptate or only with few inconspicuous septa; on *Astragalus*, Asia, Europe
..... *E. caulicola* (Petr.) U. Braun
- 6* Chasmothecia smaller, and/or appendages thin-walled, distinctly pluriseptate, not confined to stems 7
7. Chasmothecial appendages at least thick-walled towards the base, aseptate or only with few rather inconspicuous septa, verruculose 8
- 7* Chasmothecial appendages thin-walled, distinctly pluriseptate, smooth or only faintly rough-walled 9
8. Chasmothecia 90–120 µm diam., appendages brown throughout or brown below and paler towards the tip when mature, usually unbranched, only occasionally irregularly branched, with short branchlets; on *Baptisia* spp., North America
..... *E. baptisiicola*
- 8* Chasmothecia large, 90–180 µm diam., appendages colorless or only faintly pigmented at the base, rather narrow, 3.5–8.5 µm, at first unbranched, but apex always irregularly to dichotomously branched when fully mature (on *Anthyllis* and *Hedysarum*, Asia and Europe, see immature samples of *E. hedysari*) or appendages 5–10.5 µm wide, causing deformations and defoliations of the hosts (on *Alhagi* and *Sophora*, Asia, see immature samples of *E. bremeri*)
9. Chasmothecia small, 65–100(–110) µm diam., asci 2–7-spored, ascospores small, 14–20 × 9–13.5 µm; on *Cercis*, China *E. cercidis* T. Xu
- 9* Chasmothecia and ascospores larger 10
10. Asci with 2–4 rather large ascospores; conidiophores with short, straight foot-cells, 20–30 µm long; on *Hoffmannseggia*, South America, Argentina
..... *E. deserticola* Speg.
- 10* Asci (2–)3–8-spored; foot-cells of the conidiophores longer or curved-sinuous; on other hosts 11
11. Chasmothecia scattered to usually gregarious, appendages pigmented, at least brown in the lower half, 4–10 µm wide, asci 3–5(–6)-spored; foot-cells of the conidiophores straight; on *Pisum* and numerous other hosts, worldwide
..... *E. pisi* var. *psii*
- 11* Chasmothecia characteristically (regularly) scattered, appendages colorless or only faintly pigmented, yellowish, narrow, (2–)3–6(–8) µm wide, asci 4–8-spored; foot-cells of the conidiophores curved-sinuous; on *Amphicarpa*, *Desmodium*, *Glycine*, *Lespedeza* 12

12. Asci 4–7-spored, mostly 5–6-spored; on *Amphicarpaea*, *Desmodium*, *Glycine*, North America and Asia *E. glycines* F.L. Tai
- 12* Asci 6–8-spored; on *Lespedeza*, Asia *E. lespedezae* R.Y. Zheng & U. Braun
- 13(2*) Appendages short, 0.5–4 times the chasmothecial diam., strongly sinuous-geniculate, contorted, apex often simple, branchings rarely developed, wall mostly thickened and verruculose; on *Alhagi*, *Anthyllis*, *Genista*, *Hedysarum*, *Robinia*, *Sophora*, *Thermopsis*, Asia and Europe, or *Sesbania*, South America 14
- 13* Appendages very long, mostly 3–10 times the chasmothecial diam., when relatively short, appendages rather stiff, not mycelioid; on other host genera and also on *Sophora* 18
14. Mycelium dense, persistent, causing deformations and defoliations, “witches’ brooms;” on *Alhagi* and *Sophora*, Asia *E. bremeri*
- 14* Mycelium amphigenous and caulicolous, subpersistent, without deformations or defoliations; on other host genera 15
15. Chasmothecia large, (95–)110–170(–180) μm diam., appendages 5–20, narrow, 3.5–8.5 μm wide, tips in fully mature samples often recurved, appendages in mature samples strongly rough-walled; on *Anthyllis maura*, *Hedysarum* spp., Asia and Europe *E. hedysari*
- 15* Chasmothecia smaller, about 80–140 μm diam., appendages wider, up to about 10 μm , tips straight; on other hosts 16
16. Appendages very numerous, 10–40, mostly more than 20, faintly rough-walled; on *Genista*, *Melilotus*, *Thermopsis*, Asia, Armenia *E. thermopsidis*
- 16* Appendages less numerous, about 6–25, mostly 10–20, distinctly rough-walled, often coarsely verruculose 17
17. Asci (4–)5–6(–7)-spored, ascospores small, 14–20 \times 10–15 μm ; foot-cells of the conidiophores 30–65 μm long; on *Robinia*, China *E. robiniicola*
- 17* Asci (2–)3–4(–5)-spored, ascospores larger, 20–28 \times 9–12 μm ; foot-cells of the conidiophores shorter, 20–45 μm ; on *Sesbania*, South America *E. sesbaniae*
- 18(13*) Appendages either \pm horizontally spread, septate and pigmented, at least up to the middle of the stalk, or appendages with a tendency to turn towards one direction, aseptate or 1(–2)-septate, hyaline or only pigmented at the very base, flexuous, but not mycelioid, most appendages simple, only a varying percentage apically 1–3 times branched in fully mature samples, branchings diffuse, wide (*E. trifoliorum* complex: *E. astragali*, *E. baeumleri*, *E. baptisiae*, *E. intermedia*, *E. trifoliorum*) 19
- 18* Appendages mycelioid, irregular, sinuous-geniculate (on *Astragalus* or *Spartium*), apex frequently dichotomously branched 24
19. Appendages frequently branched in mature samples, with a moderate tendency to turn towards one direction, tips of the ultimate branchlets straight; on *Vicia*, North America, Asia, Europe *E. baeumleri*
- 19* Branched appendages rare; on other host genera 20

20. Appendages mostly with a conspicuous tendency to turn towards one direction, sometimes even subfasciculate, tips of the ultimate branchlets in fully mature samples often recurved; on *Astragalus* and *Oxytropis* *E. astragali*
- 20* Appendages horizontally spread, tips of the ultimate branchlets straight to somewhat curved or appendages only with a slight to moderate tendency to turn towards one direction and tips straight; on various other host genera ... 21
21. Chasmothecia small, 70–90(–105) µm diam., appendages evidently verrucose, at least below, caulicolous; on *Desmanthus*, USA *E. desmanthi*
- 21* Chasmothecia larger, on average > 90 µm, appendages smooth to verruculose towards the base; on other hosts 22
22. Foot-cells of the conidiophores usually curved to flexuous, sinuous; appendages horizontally spread, aseptate, colorless; on *Baptisia*, Europe *E. baptisiae*
- 22* Foot-cells of the conidiophores usually straight, only occasionally slightly curved or sinuous; appendages either septate and pigmented below the septa or with a tendency to turn towards one direction 23
23. Appendages 0–1-septate, hyaline or only pigmented at the very base, often with a slight to moderate tendency to turn towards one direction; on *Lupinus* *E. intermedia*
- 23* Appendages 0–6-septate, pigmented at least in the lower half, usually horizontally spread; on *Trifolium* and hosts of various other genera *E. trifoliorum*
- 24(18*) Appendages smooth to faintly rough-walled, branchlets of different orders frequently recurved, flexuous to curled, tips mostly recurved to almost spirally coiled; on *Astragalus*, Asia, North America *E. crispula*
- 24* Appendages evidently verrucose, only primary branches sometimes recurved, tips straight to partly recurved; on *Spartium*, Mediterranean region *E. rayssiae*

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Literature cited

- Amano K. 1986. Host Range and Geographical Distribution of the Powdery Mildew Fungi. Japan Scientific Societies Press, Tokyo.
- Braun U. 1984. Descriptions of new species and combinations in *Microsphaera* and *Erysiphe* (V). Mycotaxon 19: 375–383.
- Braun U. 1985. The *Erysiphe*–*Microsphaera* complex on *Fabaceae*. Zentralblatt für Mikrobiologie 140: 398–417.
- Braun U. 1987. A monograph of the *Erysiphales* (powdery mildews). Beihefte zur Nova Hedwigia 89: 1–700.
- Braun U. 1995. The powdery mildews (*Erysiphales*) of Europe. G. Fischer Verlag, Jena.

- Braun U, Cook RTA, Inman AJ, Shin H-D. 2002. The taxonomy of the powdery mildew fungi. 13–55, in R Bélanger et al. (eds.): The powdery mildews: a comprehensive treatise. St. Paul, APS Press.
- Braun U, Kummer V, Xu B. 2009. Taxonomy and nomenclature of powdery mildew fungi: *Erysiphe asclepiadis*, *E. robiniicola* and *Golovinomyces caulicola*. Mycotaxon 107: 285–295.
- Braun U, Takamatsu S. 2000. Phylogeny of *Erysiphe*, *Microsphaera*, *Uncinula* (*Erysipheae*) and *Cystotheca*, *Podosphaera*, *Sphaerotheca* (*Cystothecaceae*) inferred from rDNA ITS sequences – some taxonomic consequences. Schlechtendalia 4: 1–33.
- Eliade E. 1990. Monografia Erysiphaceelor din România. Lucrările Grădinii Botanice din București 1989–1990: 105–574.
- Heluta VP. 1998. Distribution of *Erysiphe* and *Microsphaera* species (*Erysiphales*) by phylogenetic groups of legumes. Ukrayins'kyi Botanichnyi Zhurnal 55: 481–486.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index herbariorum, Part. 1: The Herbaria of the World. 8th edn. Regnum vegetabile 120: 1–693.
- Liu T, Braun U. 2009. Taxonomic notes on some powdery mildews from Inner Mongolia. Mycotaxon 109: 21–27.
- Mayor E. 1968. Champignons observés à Neuchâtel dans les jardins de l'Institut de botanique de l'Université. Bulletin de la Société Neuchâteloise des Sciences Naturelles 91: 43–54.
- Mori Y, Sato Y, Takamatsu S. 2000. Evolutionary analysis of the powdery mildew fungi using nucleotide sequences of the nuclear ribosomal DNA. Mycologia 92: 74–93.
- Saenz GS, Taylor JW. 1999. Phylogeny of the *Erysiphales* (powdery mildews) inferred from internal transcribed spacer ribosomal DNA sequences. Canadian Journal of Botany 77: 150–168.
- Wallroth FW. 1819a. Naturgeschichte des *Mucor Erysiphe* L. Verhandlungen der Gesellschaft Naturforschender Freunde zu Berlin 1: 6–45.
- Wallroth FW. 1819b. De Mucore Erysiphae Linnaei. Annalen der Wetterauischen Gesellschaft für die Gesamte Naturkunde 4: 226–247.
- Wojciechowski MF, Levin M, Sanderson MJ. 2004. A phylogeny of legumes (*Leguminosae*) based on analysis of the plastid matK gene resolves many well-supported subclades within the family. American Journal of Botany 91: 1846–1862.

Two new marasmielloid fungi widely distributed in the Republic of Korea

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Abstract— Two species of the genus *Marasmiellus*, *M. koreanus* and *M. rhizomorphigenus*, are described as new taxa from the Republic of Korea. Both have been recorded several times during the past years. Their systematic positions are supported through DNA analyses.

Key words — euagarics, DNA studies

Introduction

During joint field excursions sponsored by the Czech-Korean project, “Phylogenetic taxonomy of *Marasmius* (*Basidiomycota*, *Marasmiaceae*) and related genera in the Republic of Korea”, several interesting marasmiod, marasmielloid, and gymnopoid fungi have been collected. Some results have already been published (Antonín et al. 2009a,b, 2010). The two new marasmielloid taxa presented here were rather frequently found at several South Korean localities.

Materials and methods

Macroscopic descriptions of collected specimens are based on fresh basidiocarps and made by the first author. Microscopic features are described from dried material mounted in H₂O, KOH, Melzer’s reagent, and Congo Red using an Olympus BX-50 light microscope with a magnification of 1000×. For basidiospores, the factors E (quotient of

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length and width in any one spore) and Q (mean of E-values) are used. For lamellae, L stands for the number of entire lamellae and l for the number of lamellulae between each pair of entire lamellae. Authors of fungal names are cited according to the International Plant Names Index Authors website (<http://www.ipni.org/ipni/authorsearchpage.do>), and colour abbreviations follow Kornerup & Wanscher (1983). Herbarium specimens of the studied fungi are preserved in the herbarium of the Moravian Museum, Brno, Czech Republic (BRNM).

DNA extraction, PCR amplification of ITS and LSU regions of ribosomal DNA, sequencing, and sequence alignment methods followed Antonín et al. (2010). Phylogenetic analyses were made using Bayesian modelling (Geyer 1991) performed with MRBAYES, version 3.0b4 (Ronquist & Huelsenbeck 2003). For a given data set, the general time reversible (GTR) model as selected with Modeltest v 3.06 (Posada & Crandall 1998) was employed with gamma-distributed substitution rates. Markov chains were run for 2,000,000 generations, saving a tree every 100th generation. Among these, the first 1000 trees were discarded as the burn-in phase of each analysis. MRBAYES was used to compute a 50 % majority rule consensus of the remaining trees to obtain estimates for the posterior probabilities (PPs) of the groups. Two species of *Marasmius*, *M. rotula* and *M. capillaris*, were selected as outgroup taxa for rooting purposes.

Taxonomy

***Marasmiellus koreanus* Antonín, R. Ryoo & H.D. Shin, sp. nov.**

FIG. 1

MYCOBANK MB 516550

NCBI ACCESSION NUMBERS: BRNM 714972 [GU319113 (ITS), GU319117 (LSU)];

BRNM 718782 [GU319114 (ITS), GU319118 (LSU)]

Pileo 27–60 mm lato, hemisphaerico usque ad planum-convexum, centro leviter depresso, subtiliter tomentoso, sulcato, griseo-aurantiaco, brunneo-aurantiaco vel brunneo. Lamellis distantibus, pallide luteis vel aurantiaco-albidis. Stipite 14–70 × 2–3.5(–5) mm, furfuraceo, albido, pallide luteo vel aurantiaco-albido. Basidiosporis 7.5–10(–11) × (3.5–)4.0–5.0(–5.5) µm, fusiformibus, ellipsoideo-fusiformibus vel ellipsoideis, hyalinis, inamyloideis. Cheilocystidiis 25–55 × 4.0–10 µm, cylindratis, clavatis, fusiformibus vel subutriformibus, irregularibus, coralloideis vel submoniliformibus. Pileipellis ex hyphis cylindratis, incrustatis, laevibus vel disperse diverticulatis constitua. Caulocystidiis 18–70(–105) × (4.0–)6.0–10 µm, cylindratis, clavatis, subulatis, fusiformibus, iterum diverticulatis. Hyphis fibulatis, indextrinoideis. Ad ramulos putridos.

HOLOTYPE: Korea meridionalis, Chiaksan, Wonju, 19. VII. 2009 leg. V. Antonín (09.125) et R. Ryoo (*holotypus* in herbario BRNM 718782 *preservatur*).

BASIDIOCARPS single or in groups. PILEUS 27–60 mm broad, hemispherical with plane to (slightly) depressed centre, then plano-convex with almost applanate to slightly depressed centre and with low and obtuse central umbo within this depression, margin inflexed and crenulate, undulate when old, finely (fibrillose) tomentose especially at centre, except for smooth centre distinctly radially rugulose-sulcate and finely innately fibrillose (under a lens), translucently striate when moist, greyish orange, brownish orange or brown (6B4–C5, 6–7C5, 7E7) with paler, almost whitish margin. LAMELLAE distant,

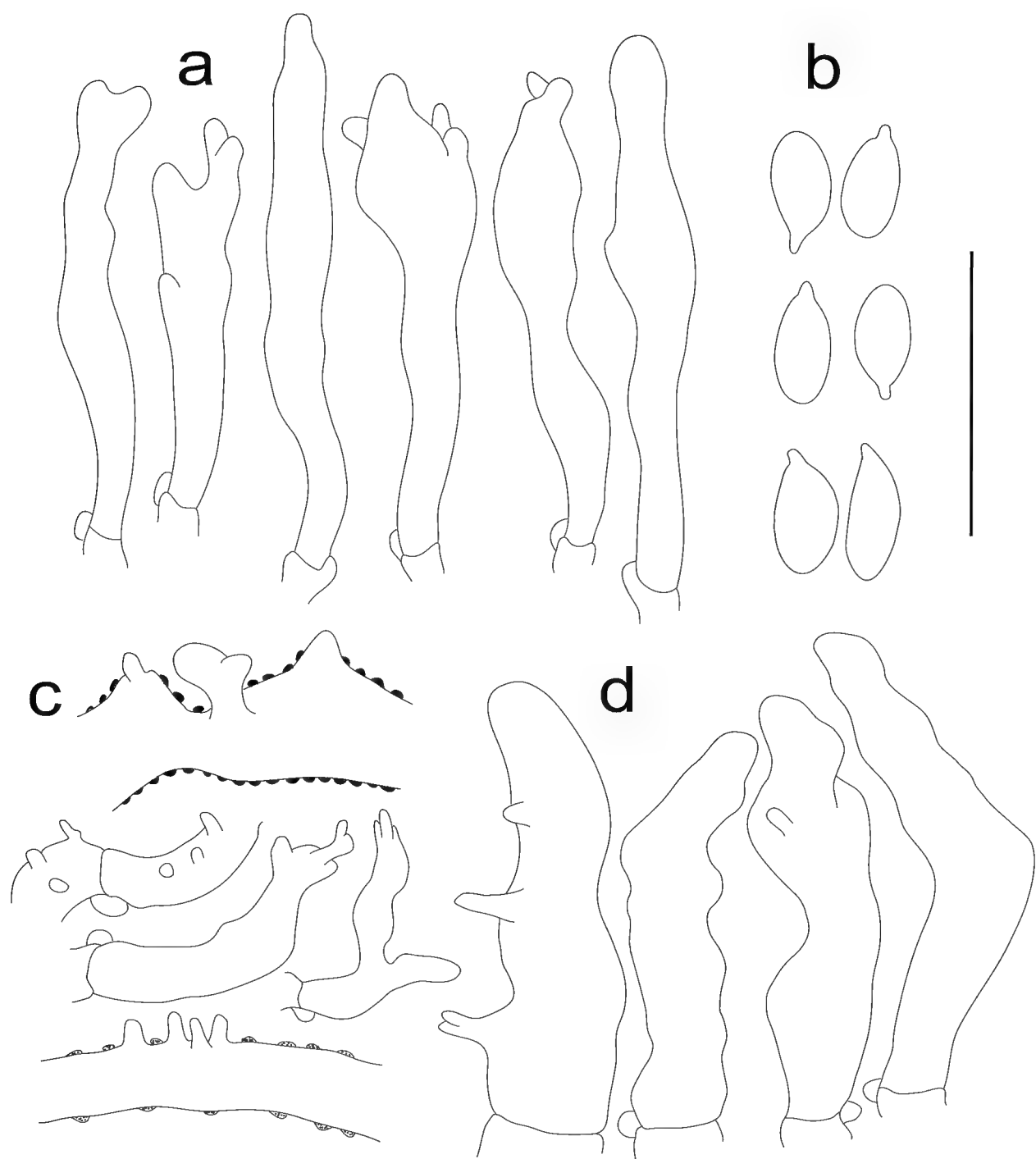


FIG. 1. *Marasmiellus koreanus*.
a. cheilocystidia, b. basidiospores, c. pileipellis hyphae, d. caulocystidia.
Scale bar = 20 μ m.

L = 15–20, l = (1–)2–3 (irregular), \pm broadly adnate with tooth, \pm arcuate when young, slightly intervenose towards pileus margin, light yellow to orange white (4–5A2, 4A3), with concolorous, finely pubescent edge. STIPE 14–70 \times 2–3.5 (–5.0) mm, cylindrical or slightly tapering towards base, sometimes laterally compressed (especially when old), slightly broadened above, subbulbous at base, (sub)insititious, longitudinally fibrillose, entirely furfuraceous especially when young, later \pm tomentose-furfuraceous especially in upper part, whitish to light yellow to orange-white (\pm lamellae colour); with whitish basal hairy

tomentum descending to the substrate (± 1 mm). CONTEXT membranaceous, whitish, hollow in stipe, without special smell, taste mild.

BASIDIOSPORES $7.5\text{--}10(-11) \times (3.5\text{--})4.0\text{--}5.0(-5.5)$ μm , average = 8.7×4.4 μm , $E = 1.6\text{--}2.4(-2.5)$, $Q = 1.8\text{--}2.0(-2.2)$, fusoid, ellipsoid-fusoid or (broadly) ellipsoid, smooth, hyaline, thin-walled, non-dextrinoid. BASIDIA $27\text{--}40 \times 8.0\text{--}10$ μm , 4-, rarely 2-spored, clavate. BASIDIOLES $15\text{--}35(-45) \times 3.0\text{--}10$ μm , cylindrical, clavate or fusoid. CHEILOCYSTIDIA $25\text{--}55 \times 4.0\text{--}10$ μm , variable in shape, cylindrical, clavate, fusoid, subutriform, irregular, lobed, sometimes rostrate, with broad, obtuse projection(s), coralloid or submoniliform, thin- to slightly-walled. TRAMA HYPHAE \pm cylindrical, thin- to slightly thick-walled, non-dextrinoid, up to $10(-15)$ μm wide. PILEIPELLIS a cutis composed of cylindrical, radially arranged, mostly coarsely incrustated (zebroid), smooth to often scatteredly diverticulate, non-dextrinoid, up to $8.0(-12)$ μm wide hyphae; terminal elements and lateral projections rarely incrustated, vesiculose, conical or cylindrical, with diverticula or not, sometimes subcoralloid; incrustation dark (grey-)brown in KOH. PILEOCYSTIDIA absent. STIPITPELLIS a cutis of cylindrical, parallel, slightly thick-walled, incrustated, smooth or scatteredly diverticulate, non-dextrinoid, up to 6.0 μm wide hyphae. CAULOCYSTIDIA numerous, adpressed to erect, $18\text{--}70(-105) \times (4.0\text{--})6.0\text{--}10$ μm , cylindrical, clavate, subulate, fusoid, mostly (slightly) irregular or moniliform, sometimes diverticulate, obtuse, thin-walled. CLAMP CONNECTIONS present in all tissues.

HABITAT — On dead twigs of broadleaf trees and *Pinus densiflora* in a mixed forest with dominating *Pinus densiflora*, *Quercus mongolica* and *Acer* sp.

ADDITIONAL COLLECTIONS — Chuncheon, Dongsan-myeon, Bongmyeong-ri, Experimental forest of Kangwon National University, $37^{\circ} 46' 46''$ N, $127^{\circ} 48' 59''$ E, alt. c. 212 m, 22 July 2007 leg. V. Antonín and R. Ryoo (Antonín 07.106, 07.107, BRNM 714972 and 714973). – Ibid., 15 Aug. 2008, leg. R. Ryoo KG 247 (BRNM 721948). – Wonju, 4 July 2008 leg. J.G. Han (Antonín 08.71, BRNM 718700). – Deogyusan National Park, Cheon-yeon Falls, 24 Aug. 2007 leg. R. Ryoo KG 155 (BRNM 721947). – Heogseong, Seowon-myeon, 28 Aug. 2007 leg. R. Ryoo KG 167 (BRNM 721949). – Ibid., 21 Aug. 2008, leg. R. Ryoo KG 251 (BRNM 721950).

REMARKS — *Marasmiellus koreanus* is a rather robust fungus characterised by a brownish orange, rugulose pileus (except for the centre), light yellow, broadly adnate lamellae, a long, whitish to light yellow stipe, moderately large, fusoid, ellipsoid-fusoid, or (broadly) ellipsoid basidiospores, variably shaped cheilocystidia, a pileipellis missing a Ramealis-structure, and numerous cylindrical, clavate, subulate, fusoid, mostly (slightly) irregular or moniliform, sometimes diverticulate caulocystidia. According to Singer (1973), it belongs to sect. *Dealbati* Singer, subsect. *Quercini* Singer.

Among similar species, *Marasmiellus ramorum* Singer is distinguished by a smaller (± 11 mm broad) pileus, a smaller ($13\text{--}14 \times 1$ mm) stipe that is brownish below, narrower basidiospores [$8.5\text{--}10.3 \times 3\text{--}3.2(-4)$ μm], and differently

shaped cheilocystidia (Singer 1973). *Marasmiellus enodis* Singer has a smaller (≤ 19 mm broad) brown pileus, lamellae concolorous with pileus, a shorter ($7\text{--}21 \times 0.5\text{--}2$ mm) stipe that browns from the base, smaller basidiospores ($6.5\text{--}9 \times 2.5\text{--}4(-4.5)$ μm), and a stipe covering of *Crinipellis*-type hyphae (Singer 1973). *Marasmiellus dendroegrus* Singer is distinguished by a smaller ($9\text{--}19$ mm broad) striate pileus, a smaller ($13\text{--}26 \times 1\text{--}2$ mm) stipe soon entirely cinnamon to deeply chestnut coloured, and smaller basidiospores ($6\text{--}8.5 \times 2.8\text{--}4.5$ μm) (Singer 1973). *Marasmiellus synodicus* (Kunze) Singer has only a $3\text{--}9$ mm broad pileus, a short stipe ($5\text{--}8 \times 0.5\text{--}1$ mm), and smaller basidiospores [$(3.5\text{--})4.5\text{--}6(-6.5) \times 2.2\text{--}3.5(-3.7)$ μm] and lacks distinct cheilocystidia (Singer 1973). *Marasmiellus stenophyllus* (Mont.) Singer is also smaller (pileus $2\text{--}15$ mm broad, stipe $6\text{--}15 \times 0.5\text{--}1.7$ mm) and produces smaller basidiospores ($6.8\text{--}8 \times 2.7\text{--}3.5$ μm) and different cheilocystidia (Singer 1973).

***Marasmiellus rhizomorphigenus* Antonín, R. Ryoo & H.D. Shin, sp. nov.** FIG. 2

MYCOBANK 516551

NCBI ACCESSION NUMBERS: BRNM 714969 [GU319115 (ITS), GU319119 (LSU)];

BRNM 715003 [GU319116 (ITS), GU319120 (LSU)]

Pileo 6–20 mm lato, late convexo, late conico usque ad planum, centro leviter depresso, ruguloso-plicato, pubescente-tomentoso, albido vel pallide griseo, centro pallide griseo-brunneo. Lamellis distantibus, albidis vel pallide luteis. Stipite 5–20 × 0.5–1.5 mm, cylindraceo vel ad basim attenuato, pubescente vel furfuraceo, apicem albido vel pallide luteo, ad basim obscure brunneo-griseo vel griseo-brunneo. Rhizomorphis praesentibus. Basidiosporis 13.5–17 × 4.5–6.5 μm , fusiformibus, clavatis vel lacrimoideis, hyalinis, inamyloideis. Cystidiis hymenialibus 34–70 × 8.0–14 μm , (sub)fusiformibus, rostratis, tenui- vel leviter crassitunicatis. Pileipellis ex hyphis cylindraceis, laevibus vel leviter incrustatis. Pileocystidiis 35–140 × 6.0–14 μm , lageniformibus, subulatis vel fusiformibus, rostratis, tenui- vel leviter crassitunicatis. Caulocystidiis 35–140 × (5.0–)6.0–12 μm , cylindraceis, subulatis, sublageniformibus, iterum rostratis, tenui- vel leviter crassitunicatis. Hyphis fibulatis, indextrinoideis. Ad ramulos putridos.

HOLOTYPE: Korea meridionalis, Hongcheon, Bukbang-myeon, Seongdong-ri, 27. VI. 2007 leg. V. Antonín 07.148 (*holotypus* in herbario BRNM 715003 preservatur).

BASIDIOCARPS single or in groups. **PILEUS** 6–20 mm broad, broadly convex to broadly conical with obtuse or papillate centre and involute to inflexed margin when young, then \pm broadly conical to almost applanate with plane to slightly depressed centre (sometimes still with obtuse papilla), and with straight to uplifted irregular margin, smooth or rugulose at the very centre, rugulose-plicate otherwise, margin crenulate, hygrophanous, translucently striate when moist, surface entirely finely pubescent-tomentose to tomentose, white or greyish tinged with pale greyish brown (6D2–3, 6E3–4) coloured centre. **LAMELLAE** distant, $L = 10\text{--}18$, $l = 0\text{--}2$, broadly adnate to shortly decurrent, lamellulae very narrow, irregular to branched, intervenose especially when old, mostly not reaching the pileus margin when old, whitish to pale yellowish

(3–4A2), sometimes with greyish tinge when old, with concolorous, finely pubescent edge. STIPE 5–20 × 0.5–1.5 mm, central, usually cylindrical and slightly broadened at apex or tapering towards base, rarely slightly broadened (up to 1.25 mm) towards base, insititious, finely fibrillose and sometimes twisted, entirely whitish pubescent to (especially at apex) furfuraceous, concolorous with lamellae at apex, brownish grey or greyish brown (6E3–4, 7E2) towards base. RHIZOMORPHS present, numerous, strigose, dark brown to black-brown, smooth. CONTEXT membranaceous, without special smell and taste.

BASIDIOSPORES 13.5–17 × 4.5–6.5 µm, average = 15.2 × 5.3 µm, E = 2.4–3.6, Q = 2.7–3.3, fusoid, lacrimoid, clavate, sometimes curved, smooth, hyaline, thin-walled, non-dextrinoid. BASIDIA 43–52 × 11–15 µm, 1-, 2-, 3- and 4-spored (4-spored ones seem to be the most frequent), clavate. BASIDIOLES 25–52 × 5.0–10(–16) µm, cylindrical or (broadly) clavate. HYMENIAL CYSTIDIA 34–70 × 8.0–14 µm, fusoid, (sub)lageniform, rostrate, obtuse, thin- to slightly thick-walled, hyaline. TRAMA HYPHAE cylindrical to subinflated, thin- to slightly thick-walled, hyaline, non-dextrinoid, up to 20 µm wide. PILEIPELLIS a cutis composed of cylindrical, radially arranged, thin- to slightly thick-walled, smooth or minutely incrustated, non-dextrinoid, up to 12 µm wide hyphae; terminal cells ± cylindrical, regular or irregular, thin-walled. PILEOCYSTIDIA 35–140 × 6.0–14 µm, lageniform, subulate, fusoid, rostrate, obtuse, thin- to slightly thick-walled (walls up to 0.75 µm). PILEOSETAE absent. STIPITPELLIS a cutis of cylindrical, parallel, thin- to slightly thick-walled, smooth or minutely incrustated, non-dextrinoid, up to 7.0 µm wide hyphae. CAULOCYSTIDIA adpressed to erect, 35–140 × (5.0–)6.0–12 µm, cylindrical, subulate, sublageniform, mostly slightly irregular or submoniliform, often rostrate, obtuse, thin- to mostly slightly thick-walled (walls up to 0.5 µm). RHIZOMORPH HYPHAE cylindrical, thick-walled, smooth, up to 4.0 µm wide, yellow-brown in KOH in cortex, similar but hyaline in medulla. CLAMP-CONNECTIONS present in all tissues.

HABITAT — On dead twigs of *Larix* sp., *Castanea serrata*, *Quercus mongolica*, *Alnus* sp. and a broadleaved tree (*Quercus*?) in mixed forests.

ADDITIONAL COLLECTIONS — Chuncheon, Dongsan-myeon, Bongmyeong-ri, Experimental forest of Kangwon National University, 37° 46' 46" N, 127° 48' 59" E, alt. c. 212 m, 22 July 2007 leg. V. Antonín and R. Ryoo (Antonín 07.99, BRNM 714969). – Ibid., 15 July 2009 leg. V. Antonín and R. Ryoo (Antonín 09.100, BRNM 718759). – Hongcheon, Gongjaksan Ecological Park, 16 July 2009 leg. V. Antonín and R. Ryoo (Antonín 09.111, BRNM 718771). – Guri, Donggureung (Nine East Tombs), 37° 36' 59" N, 127° 07' 56" E, alt. c. 35 m, 11 July 2009 leg. V. Antonín and R. Ryoo (Antonín 09.70, BRNM 718731).

REMARKS — *Marasmiellus rhizomorphigenus* is characterised by having a greyish to whitish pileus, irregular to branched lamellae that are intervenose especially when old, a short stipe often tapering towards base that is concolorous with lamellae at the apex and brownish grey or greyish brown towards base,

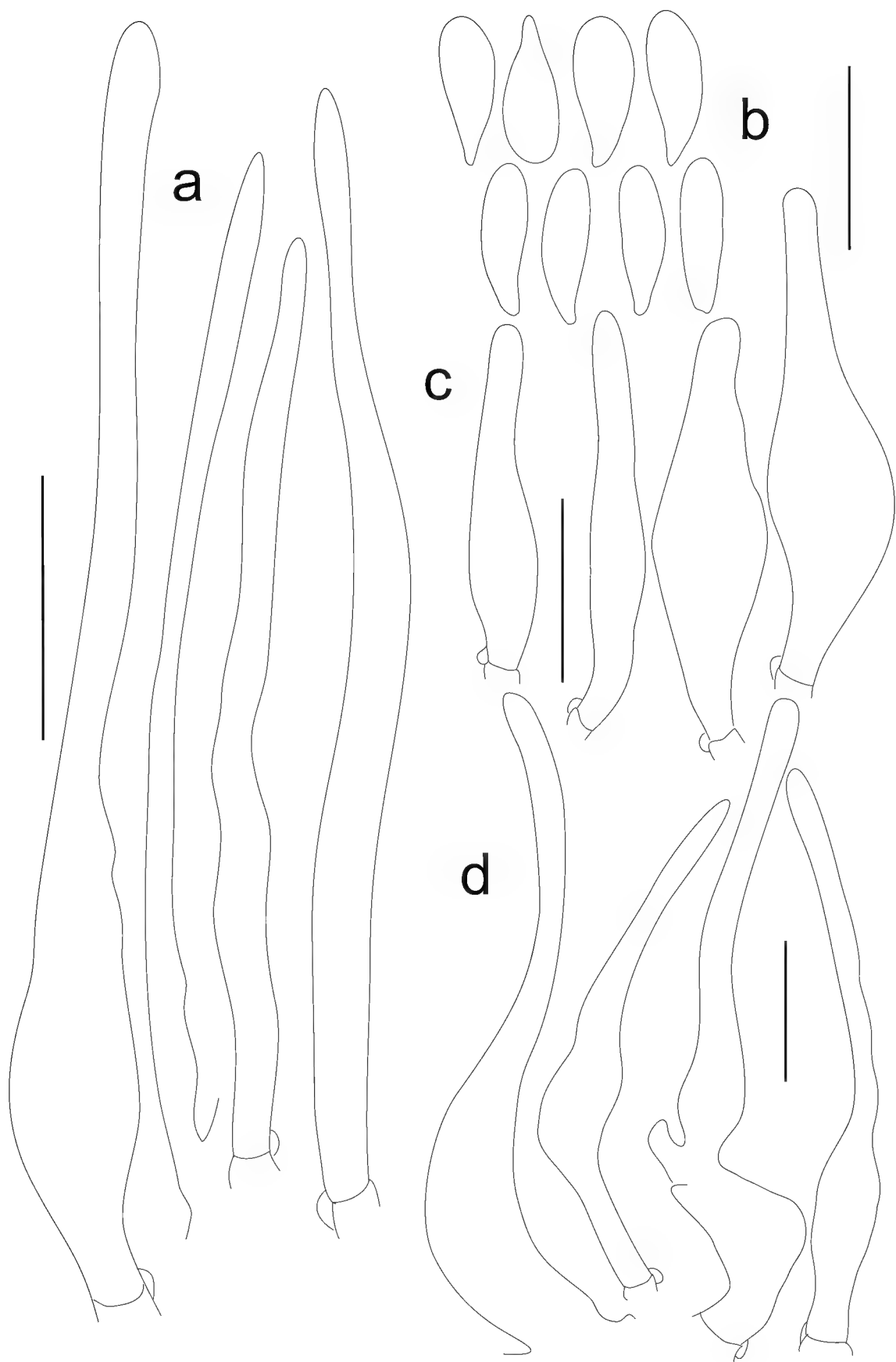


FIG. 2. *Marasmiellus rhizomorphigenus*.
a. caulocystidia, b. basidiospores, c. hymenial cystidia, d. pileocystidia.
Scale bar = 20 μ m.

well-developed rhizomorphs, rather large basidiospores, well-developed fusoid or (sub)lageniform hymenial cystidia, the presence of pileocystidia, and the absence of pileosetae. These characters place it in *Marasmiellus* sect. *Candidi* Singer according to traditional systematics (Singer 1973).

The macroscopically very similar species *M. candidus* (Bolton) Singer especially differs by the absence of rhizomorphs and distinct pileocystidia (Antonín & Noordeloos 2010); this species has already been recorded from the Korean Peninsula (Wojewoda et al. 2004). On the other hand, the fungus published as *M. candidus* with a photo by Park & Lee (1991) represents our *M. rhizomorphigenus*. *Tetrapyrgos nigripes* (Schwein.) E. Horak differs by the shape of its basidiocarps (stipe longer than pileus diameter), the tetrahedric shape of the basidiospores, a different pileipellis structure, and the absence of rhizomorphs and setoid pileocystidia. *Marasmiellus albofuscus* (Berk. & M.A. Curtis) Singer has a reticulate-sulcate pileus, a pallid to white stipe, and slightly smaller basidiospores ($10.8\text{--}15.3 \times 3.5\text{--}6.2 \mu\text{m}$). *Marasmiellus subnigricans* (Murrill) Singer has a larger (15–40 mm), white pileus that ages or dries to deep fuscous or blackish, often blackish lamellae, a white stipe becoming black-punctate, and smaller basidiospores ($10.2\text{--}14.5 \times 3.5\text{--}4.3 \mu\text{m}$). Moreover, neither *M. albofuscus* nor *M. subnigricans* form rhizomorphs (Singer 1973).

No previously described rhizomorph-forming species (Desjardin et al. 1993, Singer 1973) belongs to sect. *Candidi*. The macroscopically very close *Marasmiellus tenerrimus* (Berk. & M.A. Curtis) Singer differs by a pileus that appears finely cinnamon punctate under a lens, a smaller stipe ($5\text{--}12 \times 0.3\text{--}0.4 \text{ mm}$), shorter hymenial cystidia ($20\text{--}27 \times 4\text{--}6 \mu\text{m}$), and the presence of pileosetae (Desjardin et al. 1993, Singer 1973).

Phylogenetic analyses

The phylogenetic relationships of *Marasmiellus koreanus* and *M. rhizomorphigenus* were inferred from Bayesian (MCMC) analyses based on internal transcribed spacer (ITS) and nuclear ribosomal large subunit (LSU) rDNA sequences obtained in this study and from GenBank. ITS and LSU sequences were aligned and the ends trimmed to create a dataset of 561 and 797 base pairs, respectively. The resulting phylogenetic trees are shown in FIG. 3 (ITS) and FIG. 4 (LSU).

The phylogeny inferred from LSU and ITS sequences support the isolated position of the species delimited by macro- and micro-morphological characteristics. The independent taxonomic status of the two new *Marasmiellus* species in relation to other closely related species was concordant with high posterior probability. The results of this study were supported by the phylogenetic relationships and placement of *Marasmiellus* s.l. in previous studies by Mata et al. (2004) and Wilson & Desjardin (2005).

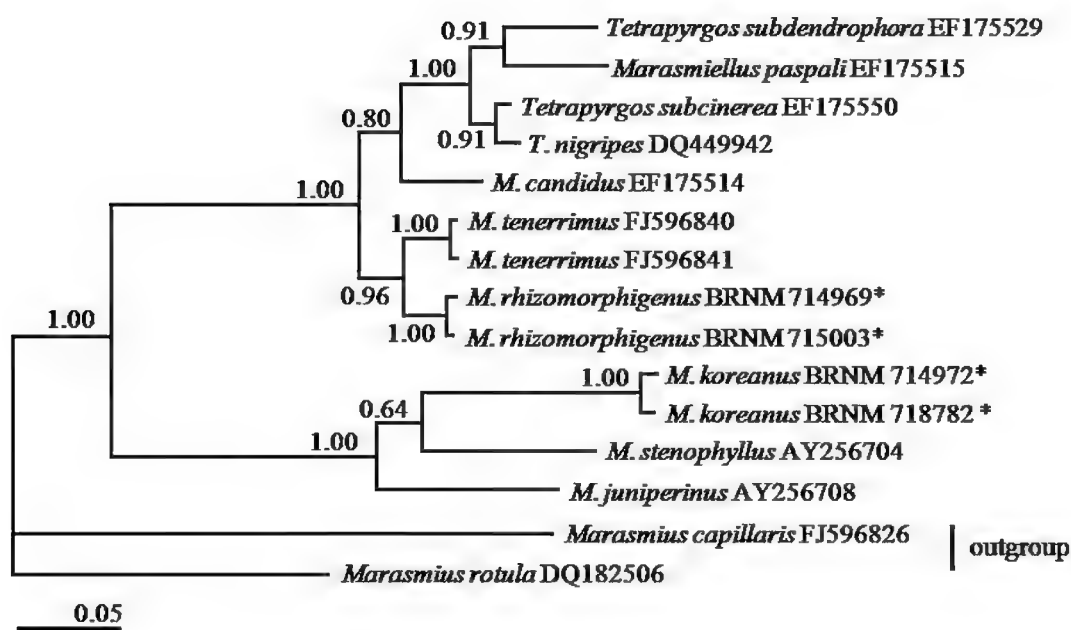


FIG. 3. Phylogenetic tree of *Marasmiellus koreanus* and *M. rhizomorphigenus* based on ITS rDNA sequences, showing mean branch lengths of a 50 % majority-rule consensus tree from a MCMC analysis. An asterisk (*) denotes taxa sequence on this study. The bar indicates number of expected substitutions per position.

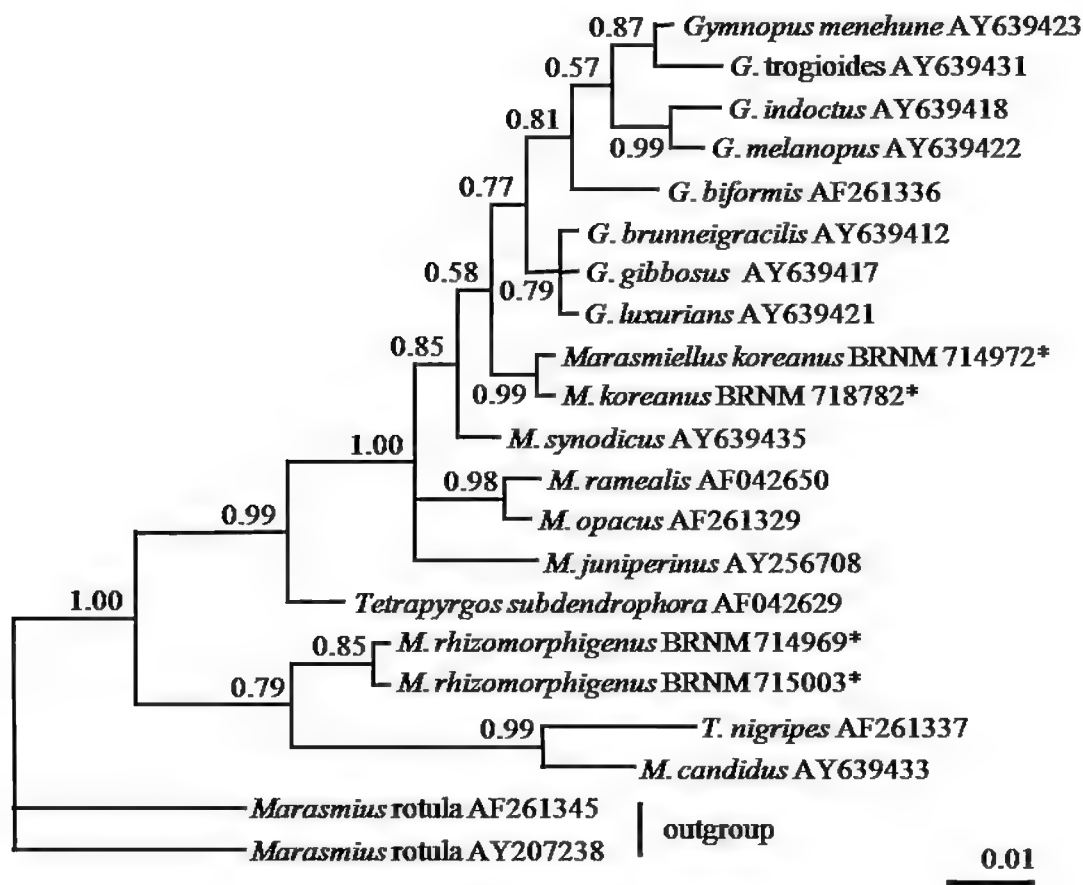


FIG. 4. Phylogenetic tree of *Marasmiellus koreanus* and *M. rhizomorphigenus* based on the nLSU rDNA sequences, showing mean branch lengths of a 50 % majority-rule consensus tree from a MCMC analysis. An asterisk (*) denotes taxa sequence on this study. The bar indicates number of expected substitutions per position.

Both ITS and LSU sequences place *Marasmiellus koreanus* in the same clade with *M. juniperinus* (the type species of *Marasmiellus*) and *M. stenophyllus* (ITS) and *M. synodicus*, *M. ramealis*, and *M. opacus* (LSU). According to the phylogenetic analyses of Mata et al. (2004) and Wilson & Desjardin (2005), *Marasmiellus juniperinus* belongs to the same clade as species of *Gymnopus* sect. *Vestipedes*. The proposed transfer of *M. juniperinus* to the genus *Gymnopus* by Mata et al. (2004) was not accepted by Wilson & Desjardin (2005). This study confirms the placement of *Marasmiellus koreanus* in the /marasmiellus clade according to Wilson & Desjardin (2005).

The other new species, *Marasmiellus rhizomorphigenus*, forms a distinct sister branch to *Tetrapyrgos* taxa in two phylogenetic trees. This species is placed in the same clade with *Marasmiellus tenerimus* from ITS analysis and with *M. candidus* from LSU analysis. According to Moncalvo et al. (2002), the /tetrapyrgos clade from the upper /tetrapyrgoid clade forms a sister clade of /marasmiod; both upper clades belong to /marasmiaceae. Analogous results were published by Matheny et al. (2006). Nevertheless, Wilson & Desjardin (2005) excluded the /tetrapyrgos clade from /marasmiaceae, which corresponds to the /marasmiod clade of Moncalvo et al. (2002). In general, the phylogenetic positions of *Marasmiellus*, *Tetrapyrgos*, and *Gymnopus* sect. *Vestipedes* deserve further study.

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Literature cited

- Antonín V, Noordeloos ME. 2010. A monograph of marasmiod and collybioid fungi in Europe. IHW Verlag: Eching. 480 pp.
- Antonín V, Ryoo R, Shin HD. 2009a. *Gerronema nemorale* (Basidiomycota, Agaricomycetes): anatomic-morphological, cultivational, enzymatic and molecular characteristics and its first records in the Republic of Korea. Czech Mycol. 60(2): 197–212.
- Antonín V, Ryoo R, Shin HD. 2009b. Marasmiod and gymnopoid fungi of the Republic of Korea. 1. Three interesting species of *Crinipellis* (Basidiomycota, Marasmiaceae). Mycotaxon 108: 429–440.
- Antonín V, Ryoo R, Shin HD. 2010. Marasmiod and gymnopoid fungi of the Republic of Korea. 2. *Marasmius* sect. *Globulares*. Persoonia 24: 49–59.

- Desjardin DE, Gordon SA, Petersen RH. 1993. Observations on two rhizomorph-forming species of *Marasmiellus*. *Mycol. Res.* 97(1): 111–122.
- Geyer CJ. 1991. Markov Chain Monte Carlo maximum likelihood. 156–163, in EM. Keramidas, ed., *Computing Science and Statistics. Proceedings of the 23rd Symposium on the Interface*. Interface Foundation. Virginia.
- Kornerup A, Wanscher JH. 1983. *Methuen handbook of colour*. 3rd ed. Methuen Co., London.
- Mata JL, Hughes KW, Petersen RH. 2004. Phylogenetic placement of *Marasmiellus juniperinus*. *Mycoscience* 45(3): 214–221.
- Matheny PB, Curtis JM, Hofstetter V, Aime C, Moncalvo J-M, Ge Z-W, Slot JC, Ammirati JF, Baroni TJ, Bougher NK, Hughes KW, Lodge J, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Major clades of Agaricales: a multilocus phylogenetic overview. *Mycologia* 98(6): 982–995.
- Moncalvo J-M, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime C, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cl  men  on H, Miller OK Jr. 2002. One hundred and seventeen clades of euagarics. *Molecular Phylogenetics Evol.* 23: 357–400.
- Park WH, Lee HD. 1991. *Wild fungi of Korea*. Kyo-Hak Publishing: Seoul. 508 pp.
- Posada D, Crandall KA. 1998 Modeltest: testing the model of DNA substitution. *Bioinformatics* 14(9): 817–818.
- Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
- Singer R. 1973. The genera *Marasmiellus*, *Crepidotus* and *Simocybe* in the Neotropics. *Beih. Nova Hedwigia* 44: 1–517.
- Wilson AW, Desjardin DE. 2005. Phylogenetic relationships in the gymnopoid and marasmiod fungi (*Basidiomycetes*, euagarics clade). *Mycologia* 97(3): 667–679.
- Wojewoda W, Heinrich Z, Komorowska H. 2004. Macrofungi of North Korea collected in 1982–1986. *Polish Bot. Studies* 18: 1–289.

The lichen genus *Lepraria* (*Stereocaulaceae*) in South Korea

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Abstract — The species belonging to lichen genus *Lepraria* that occur in South Korea are revised. Seventeen taxa are accepted. Brief descriptions of the species and a key to the taxa are provided. All species described here except *L. coriensis* are new to South Korea. Among them, *L. caesiella*, *L. eburnea*, *L. leprolomopsis*, *L. lobata*, *L. pallida*, *L. texta* and *L. xerophila* are reported for first time from eastern Asia (including China and Japan).

Key words — geographical distribution, lichen-forming fungi, taxonomy

Introduction

As the name indicates, *Lepraria* Ach. (Latin *leprosus* = a scurfy soresiate appearance) is characterized by leprose thallus with an entirely soresiate surface (Laundon 1992, Tønsberg 1992) that is sometimes squamulose or with isidia like structures (Crespo et al. 2006, Tønsberg 2004, Wirth et al. 2004). The chemistry of this genus includes depsides, depsidones, usnic acids, benzyl esters, dibenzofurans, fatty acids, anthraquinones, terpenoids, and aliphatic acids.

Lepraria is a widely distributed genus that comprises ca. 61 species (Elix & Kalb 2008, Kukwa & Flakus 2009, Saag et al. 2009). It occurs in alpine, temperate, and tropical regions on soil, rock, mosses, wood, bark, and other lichens. Recent molecular studies by Ekman & Tønsberg (2002) have confirmed that it belongs to *Stereocaulaceae*.

Saag et al. (2009) have surveyed the genus on a worldwide basis. However, the East Asian species have not been critically revised. Wei (1991) reported 2 species of *Lepraria* from China [*L. incana* (L.) Ach. and *L. yunnaniana* (Hue) Zahlbr.], while Harada et al. (2004) reported 5 species from Japan [*L. cacuminum* (A. Massal.) Loht., *L. cupressicola* (Hue) J.R. Laundon, *L. lobificans*, *L. membranacea*, *L. vouauxii*]. However, only one species, *L. coriensis* (≡ *Crocynia coriensis* Hue), has been reported from South Korea (Hue 1924, Hur

et al. 2005, Kim 1981, Sato 1943). Moon (1999) reported *Lepraria* from South Korea but excluded it from her studies because of taxonomic complexities in this genus.

Herbarium study at Korean Lichen Research Institute (KoLRI) and recent collection of leprarioid lichens from different places in South Korea revealed the occurrence of 17 *Lepraria* species within this country. Except *L. coriensis*, all the species are new to South Korea. Seven taxa (*L. caesiella*, *L. eburnea*, *L. leprolomopsis*, *L. lobata*, *L. pallida*, *L. texta*, *L. xerophila*) are new to East Asia.

The present paper covers the leprarioid lichens reported from South Korea for the first time as well as species earlier reported from this part of the continent and expands the knowledge of lichen diversity in East Asia including China and Japan. A brief taxonomic description and comments are provided for each species along with a key to all the leprarioid lichens of South Korea.

Materials and methods

The study is based on lichen specimens lodged in the herbarium of Lichen & Allied Bioresource Center, Korean Lichen Research Institute (KoLRI), Sunchon National University, South Korea, as well as fresh samples collected during recent field trips. A total of thirty-five specimens have been examined under NIKON C-PS 1068908 dissecting microscope and studied with Thin Layer Chromatography (TLC) using solvents A and C, following the standardized methods of Culberson (1972), Elix et al. (1987), and White & James (1985).

Taxonomy

Key to the species of *Lepraria* in South Korea

(adapted from Saag et al. 2009 with some amendments)

- 1. Granules or lobules similar to isidia present, soredia few or absent *L. xerophila*
- 1. Granules or lobules similar to isidia absent, soredia numerous 2
- 2. Stictic acid complex present. 3
- 2. Stictic acid complex absent 5
- 3. Terpenoids present 4
- 3. Terpenoids absent *L. caesiocalba* var. *caesiocalba*
- 4. Thallus greenish; soredia fine to medium sized (20–60 µm diam.) and with long projecting hyphae; zeorin present. *L. lobificans*
- 4. Thallus yellowish; soredia medium sized to coarse (75–110 µm diam.) and with or without short projecting hyphae; zeorin absent *L. leprolomopsis*
- 5. Alectorialic acid present. 6
- 5. Alectorialic acid absent 7
- 6. Thallus soft, soredia loosely packed, medulla distinct and thick *L. eburnea*
- 6. Thallus hard, soredia densely packed, medulla inconspicuous. *L. neglecta*

7. Pannaric acid or one of pannaric acid derivatives present as main substance 8
7. Pannaric acid and its derivatives absent or in traces besides other major
dibenzofurans10
8. Lobes absent or poorly developed9
8. Lobes present *L. membranacea*
9. Thallus with less or no patches of exposed medulla; 4-oxypannaric acid 2-
methylester as major dibenzofuran*L. diffusa*
9. Thallus with exposed patches of medulla between soredia; pannaric acid 6-
methylester as major dibenzofuran*L. vouauxii*
10. Usnic acid present together with zeorin11
10. Usnic acid absent, zeorin present or absent.13
11. Distinct well developed marginal lobes present, over 0.5 mm wide and
with marginal rim. *L. coriensis*
11. Marginal lobes absent or obscure, less than 0.5 mm wide and
without marginal rim.12
12. Obscure lobes present; medulla present, thick; soredia fine to coarse
(up to 450 µm in diam.)*L. leuckertiana*
12. Obscure lobes absent; medulla absent or thin; soredia fine
(up to 50 µm in diam.) *L. texta*
13. Norascomatic acid present. *L. xerophila*
13. Norascomatic acid absent14
14. Distinct well-developed marginal lobes present, over 0.5 mm wide and with
marginal rim15
14. Marginal lobes absent or obscure16
15. Hypothallus present, gray to black; unidentified fatty acids present *L. pallida*
15. Hypothallus absent (medulla present); rangiformic/jackinic acid present . . *L. lobata*
16. Zeorin present, fatty acids present or absent.17
16. Zeorin absent, roccellic/angardianic acid present *L. celata*
17. Fatty acids absent; medulla and/or hypothallus absent *L. caesiella*
17. Fatty acids present; medulla and/or hypothallus present18
18. Thallus hard, soredia densely packed, consoredia up to 300 µm diam *L. lobata*
18. Thallus soft, soredia loosely packed, consoredia up to 160 µm diam.*L. jackii*

1. *Lepraria caesiella* R.C. Harris, Opuscula Philolichenum 2: 51, 2005

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery, pale bluish gray, margin diffuse, forming thin to thick ±continuous extensive irregularly spreading patches, or sometimes forming ±rounded colonies. Lobes absent. Soredia abundant, dispersed or forming a thick continuous layer, very fine, 20–30 µm in diam., commonly aggregated in ±round consoredia up to 100 µm diam.,

projecting hyphae present. Medulla absent. Hypothallus absent. For further descriptions see Lendemer (2005).

CHEMISTRY — Spot test reactions: thallus K⁺ faint yellow to yellow-orange, C[−], KC[−], P[−]. Secondary metabolites: Atranorin and Zeorin.

Besides atranorin and zeorin, Saag et al. (2007) also reported roccellic/angardianic acid or an unidentified fatty acid from some specimens of *L. caesiella*.

ECOLOGY — The species was found growing over *Pinus* bark at an elevation of 431 m.

GEOGRAPHICAL DISTRIBUTION — North and South America, Greenland (Saag et al. 2009); new to East Asia (South Korea).

SPECIMEN EXAMINED — South Korea: Gyongsangbuk Prov.: Mt. Kongduck, N36°44'42.5", E128°15'54.2", alt. 431 m, on *Pinus* bark, 20 June 2007, Hur 070772 (KoLRI).

REMARKS — *Lepraria jackii*, *L. lobata*, and *L. pallida* are the other atranorin and zeorin containing South Korean *Lepraria* species with which *L. caesiella* is most likely to be confused. *L. jackii* differs in having jackinic/rangiformic acid and a white hypothallus. *L. lobata* differs in having lobes and roccellic/angardianic acid, while *L. pallida* differs in having lobes and tomentose, gray to black hypothallus.

2. *Lepraria caesioalba* (B. de Lesd.) J.R. Laundon, Lichenologist 24: 324, 1992, var. *caesioalba*

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery, whitish gray to bluish gray to yellowish gray to grayish green, forming ±regular rosettes which later sometimes coalesce and form irregular patches. Margin delimited or not. True lobes absent, but obscure minute lobes sometimes present without raised rims. Soredia abundant, usually compact, coarse, 150–180(–200) µm in diam., commonly aggregated in ±round consoredia up to 200–300 µm diam., projecting hyphae sometimes present, short. Medulla present, inconspicuous, white. Hypothallus absent. For further descriptions see Laundon (1992), Lohtander (1994) and Saag et al. (2007).

CHEMISTRY — Spot test reactions: thallus K⁺ yellow, C[−], KC[−], P⁺ yellow. Secondary metabolites: Atranorin, Stictic acid complex and Zeorin (Chemotype 2). It is the most common Chemotype of this species in South Korea.

Two other chemotypes besides Chemotype 2 have been reported for this species: Chemotype 1, which is regarded as the most frequent (at least in Europe), contains atranorin, fumarprotocetraric acid, protocetraric acid and ±roccellic/angardianic or rangiformic acid, while Chemotype 3, the rarest chemotype, contains atranorin, psoromic acid and roccellic/angardianic or rangiformic acid (Leuckert et al. 1995).

ECOLOGY — *Lepraria caesioalba*, one of the most common *Lepraria* species in South Korea, has been found growing over bark, soil, and non-calcareous rocks between elevations of 70–1104 m.

GEOGRAPHICAL DISTRIBUTION — Europe, North and South America, Asia, Australasia, Antarctica, Greenland (Saag et al. 2009); new to South Korea.

SPECIMENS EXAMINED – South Korea: Jeollanam Prov.: Suncheon, Suncheon National University, N34°57'59.3", E127°28'44.8", alt. 70 m, on *Pinus densiflora*, 05 October 2005, L. Lőkös 050628 (KoLRI); Kangwon Prov.: Galjeongo bong, N37°52'952", E128°30'161", alt. 1104 m, on rock, 22 May 2009, Y. Joshi & X. Y. Wang 090589 (KoLRI); Kangwon Prov.: Mt. Seorak, N38°09'981", E128°27'267", alt. 463 m, on soil over rock, 24 May 2009, Y. Joshi & X. Y. Wang 090756, 090794 (KoLRI); Kangwon Prov.: Hange ryong, N38°05'433", E128°25'131", alt. 750 m, 25 May 2009, on dead trunk, Y. Joshi & X. Y. Wang 090902 (KoLRI).

REMARKS — *Lepraria leprolomopsis* and *L. lobificans*, which are the other stictic acid complex containing South Korean species with which *L. caesioalba* var. *caesioalba* can be confused, differ in having a well developed conspicuous medulla. *Lepraria nivalis* J.R. Laundon and *L. santosii* Argüello & A. Crespo are the other atranorin and stictic acid complex containing species with which *L. caesioalba* var. *caesioalba* is often confused. *L. nivalis* differs in having a well developed medulla, while *L. santosii* differs in having distinctly lobate thallus with thick raised marginal rims.

3. *Lepraria celata* Slav.-Bay., Lichenologist 38: 504, 2006

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery, bluish gray, margin diffuse or delimited, forming thin to thick ±continuous extensive irregularly spreading patches. Lobes absent. Soredia abundant, forming a thick continuous layer, very fine, 20–30 µm in diam., projecting hyphae absent. Medulla absent. Hypothallus sparsely present as white patches. For further descriptions see Slavíková-Bayerová & Orange (2006).

CHEMISTRY — Spot test reactions: thallus K–, C–, KC–, P–. Secondary metabolites: Atranorin and a fatty acid (roccellic/angardianic acid).

ECOLOGY — The species is found growing over non-calcareous rocks at an altitude of 1192 m.

GEOGRAPHICAL DISTRIBUTION — Europe (Saag et al. 2009); new to Asia (South Korea).

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Dongpalam valley, N37°51'359", E128°30'974", alt. 1192 m, on rock, 23 May 2009, Y. Joshi & X. Y. Wang 090670-1 (KoLRI).

REMARKS — *Lepraria lobata* and *L. neglecta* are other roccellic/angardianic fatty acid containing South Korean species with which *L. celata* may be confused. *Lepraria lobata* differs in having zeorin, distinct lobes, a medulla, and

no hypothallus, while *L. neglecta* has alectorialic acid as a major compound, obscure minute lobes, and an inconspicuous medulla.

4. *Lepraria coriensis* (Hue) Sipman, Herzogia 17: 28, 2004

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery to membranous, greenish gray, often forming irregular rosettes which later sometimes coalesce and form non-areolate appressed crust of powdery granules. Margin delimited. Lobes present, obscure or more often well developed (0.5–1.5 mm wide) with raised marginal rim. Soredia sparse to abundant, exposing smooth ecorticate surface, fine to coarse, 70–100(–250) μm in diam., commonly aggregated in \pm round consoredia up to 200–350 μm diam., projecting hyphae absent. Medulla usually present, white. Hypothallus sometimes present, brown to black. For further descriptions see Laundon (2003), Sipman (2004) and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K–, C–, KC–, P–. Secondary metabolites: Usnic acid, Zeorin, Constipatic acid (Chemotype 1). It is the commonest chemotype met within this species.

Besides Chemotype 1, two other chemotypes have been reported for this species: Chemotype 2 (usnic acid, zeorin, protodehydroconstipatic and constipatic acids, isousnic acid, argopsin, norargopsin, atranorin) and Chemotype 3 (usnic acid, zeorin, protodehydroconstipatic and constipatic acids, caloploicin, fulgidin, isousnic acid, atranorin) (Elix 2006b).

ECOLOGY — At the collection site (425 m), the species was found growing over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — Asia (India, Hong Kong, Taiwan, South Korea) and Australia (Saag et al. 2009, Elix 2009).

SPECIMEN EXAMINED – South Korea: Chungchongbuk Prov.: Mt. Songni, N36°32'34.7", E127°51'15.0", alt. 425 m, on rocks, 21 April 2006, Hur 0600023 (KoLRI).

REMARKS — The presence of distinctly lobed thallus margins with raised rims and constipatic acid separate *L. coriensis* from the two other usnic acid containing South Korean species, *L. leuckertiana* and *L. texta*. The other two species both have a diffused thallus margin or rimless lobes and lack constipatic acid.

5. *Lepraria diffusa* (J.R. Laundon) Kukwa, Ann. Bot. Fennici 39: 226, 2002

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery to cottony, grayish cream to yellowish green, diffuse, forming thin to thick \pm continuous extensive irregularly spreading patches, or sometimes forming \pm rounded colonies. Margin diffuse or rarely delimited. Lobes absent. Soredia abundant, usually compact, coarse, up to 100 μm in diam., projecting hyphae sometimes present, short. Medulla present, white. Hypothallus sometimes present, whitish gray to

brownish. For further descriptions see Laundon (1992) and Kukwa (2006).

CHEMISTRY — Spot test reactions: thallus K+ pale yellow, C–, KC–, P–. Secondary metabolites: 4-oxypannaric acid 2-methylester.

ECOLOGY — At the collection site (706 m), the species was found growing over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — Asia, Europe and North America (Saag et al. 2009); new to South Korea.

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Dongpalam valley, N37°51'692", E128°31'522", alt. 706 m, on rock, 23 May 2009, Y. Joshi & X. Y. Wang 090730-1 (KoLRI).

REMARKS — *Lepraria diffusa*, which has 4-oxypannaric acid 2-methylester as the only major dibenzofuran, might be confused with two other dibenzofuran-producing South Korean species, *L. membranacea* and *L. vouauxii*. *Lepraria membranacea*, however, has pannaric acid as the major dibenzofuran, while *L. vouauxii* has pannaric acid 6-methylester as a major secondary compound.

6. *Lepraria eburnea* J.R. Laundon, Lichenologist 24: 331, 1992

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery to cottony, white to whitish gray to bluish gray, greenish gray or yellowish gray, shape irregular. Margin diffuse to rarely delimited. Lobes usually absent, but sometimes with indistinct lobes. Soredia abundant or sparse, exposing smooth ecorticate surface, fine, 45–60 µm in diam., commonly aggregated in ±round consoredia up to 200–400 µm diam., projecting hyphae present, long. Medulla present, thick, white. Hypothallus not distinct. For further descriptions see Orange (1997) and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K– or + yellow, C– or + reddish orange, KC+ reddish orange, P+ yellow or orange. Secondary metabolite: Alectorialic acid (Chemotype 3).

Besides Chemotype 3, two other chemotypes have been reported for this species: Chemotype 1, the most frequently encountered, contains alectorialic acid and protocetraric acid, while Chemotype 2 has alectorialic acid, psoromic acid and 2'-O-demethylpsoromic acid (Orange 1997).

ECOLOGY — *Lepraria eburnea*, one of the most common *Lepraria* species in South Korea, has been found growing over bark of *Pinus densiflora* and on soil over rocks between elevations of 115–673 m.

GEOGRAPHICAL DISTRIBUTION — Europe, North America, Australasia and Greenland (Saag et al. 2009); new to East Asia (South Korea).

SPECIMENS EXAMINED – South Korea: Jeollanam Prov., Boseong Co., Mt. Illim, N34°41'17.7", E127°00'57.3", alt. 220 m, on bark, 01 September 2005, Hur 050370 (KoLRI); Hwasun Co., Mt. Baega, N35°10'32.4", E127°08'23.", alt. 320 m, on *Pinus*

densiflora bark, 08 October 2005, L. Lökös 050654 (KoLRI); Sunchon, Sunchon National University, N34°58'00.4", E127°28'32.9", alt. 115 m, on *Pinus densiflora* bark, 08 October 2005, L. Lökös 050676 (KoLRI); Haenam Co., Mt. Talmasan, N34°22'52.7", E126°34'40.8", alt. 270 m, on *Pinus densiflora* bark, 26 July 2005, Hur 050331 (KoLRI); Kangwon Prov., Mt. Seorak, N38°09'969", E128°27'831", alt. 673 m, on rock, 24 May 2009, Y. Joshi & X. Y. Wang 090835 (KoLRI).

REMARKS — *Lepraria neglecta*, another alectorialic acid containing South Korean species, differs in having a hard, granular thallus with inconspicuous medulla and densely packed soredia, in contrast to the thallus of *L. eburnea*, which is soft with a distinct medulla and loosely packed soredia.

7. *Lepraria jackii* Tønsberg, Sommerfeltia 14: 200, 1992

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery, whitish green to greenish or bluish gray, usually diffuse, forming thin to thick \pm continuous extensive irregularly spreading patches, or sometimes forming \pm rounded colonies which eventually coalesce. Margins diffuse or rarely delimited. Lobes absent. Soredia abundant, dispersed or forming a thick continuous layer, very fine to coarse, 20–40(–130) μ m in diam., commonly aggregated in \pm round consoredia 80–160 μ m diam., projecting hyphae sometimes present, short. Medulla absent. Hypothallus present, sparse to continuous, white. For further descriptions see Tønsberg (1992), Bayerová et al. (2005), Slavíková-Bayerová & Orange (2006), and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K– or + pale yellow, C–, KC–, P–. Secondary metabolites: Atranorin, Zeorin and a fatty acid (jackinic/rangiformic acid).

ECOLOGY — In South Korea, the species is found growing over bark at an altitude of 500 m.

GEOGRAPHICAL DISTRIBUTION — Europe, North America, Asia and Australia (Saag et al. 2009); new to South Korea.

SPECIMEN EXAMINED – South Korea: Chungchongbuk Prov.: Mt. Joryong, N37°48'27.0", E128°03'32.0", alt. 500 m, on bark, 10 July 2008, Hur 080314 (KoLRI).

REMARKS — *Lepraria jackii* may be confused with two other atranorin and zeorin containing South Korean species: *L. caesiella* and *L. lobata*. *Lepraria caesiella* differs in lacking jackinic/rangiformic acid and a medulla and/or hypothallus, while *L. lobata* has relatively hard thallus with densely packed soredia and bigger ($\leq 300 \mu$ m) consoredia.

8. *Lepraria leprolomopsis* Diederich & Sérus., Bibl. Lichenol. 64: 76, 1997

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery to cottony, yellowish green, forming thin to thick \pm continuous extensive irregularly spreading patches, or sometimes forming \pm rounded colonies which eventually coalesce.

Margin delimited. Lobes absent. Soredia abundant, medium sized, 75–110 μm in diam., commonly aggregated in \pm round consoredia up to 140–300 μm diam., projecting hyphae sometimes present. Medulla present, white. Hypothallus usually present, poorly developed, white. For further descriptions see Aptroot et al. (1997).

CHEMISTRY — Spot test reactions: thallus usually K+ yellow, C–, KC–, P+ pale orange. Secondary metabolites: Atranorin and Stictic acid complex.

ECOLOGY — At the collection site (285 m), the species was found growing over non-calcareous soil.

GEOGRAPHICAL DISTRIBUTION — Australasia (Papua New Guinea) (Saag et al. 2009); new to East Asia (South Korea).

SPECIMEN EXAMINED – South Korea: Chungchongbuk Prov.: Mt. Joryong, N37°01'33.3" E128°11'59.2", alt. 285 m, on soil, 28 October 2006, Hur 061111 (KoLRI).

REMARKS — *Lepraria leprolomopsis*, which may be confused with *L. lobificans*, another South Korean species containing atranorin and the stictic acid complex, can be diagnosed by its yellowish thallus, medium to coarse (75–110 μm diam.) harder soredia with or without projecting hyphae, and lack of zeorin. *Lepraria lobificans* differs in having greenish thallus, loosely packed fine to medium sized (20–60 μm diam.) soft soredia with long projecting hyphae, and zeorin.

9. *Lepraria leuckertiana* (Zedda) L. Saag, Lichenologist 41: 41, 2009

DIAGNOSTIC CHARACTERS — Thallus leprose, cottony and powdery to granular, whitish gray to bluish gray, diffuse or weakly delimited, forming \pm regular rosettes or irregular patches, firmly attached to the substratum. Margins delimited but not forming true lobes, obscure sublobes present. Soredia abundant, fine to coarse, up to 425 μm in diam., not well separated from each other. Medulla present, well developed, white, patches with exposed medulla present. Hypothallus absent. For further descriptions see Zedda (2000).

CHEMISTRY — Spot test reactions: thallus K–, C–, KC–, P–. Secondary metabolites: Usnic acid, Zeorin, Isousnic acid (traces), Triterpenes.

ECOLOGY — At the collection (1222 m), the species was found growing over bark.

GEOGRAPHICAL DISTRIBUTION — Widely distributed throughout Central and South America, Australia, southern/southeastern Asia (Singapore, Indonesia, Sri Lanka), and southern Africa (Saag et al. 2009, Elix 2009); new to South Korea.

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Gitdae bong, N37°18'367" E128°56'766", alt. 1222 m, on bark, 15 May 2009, Y. Joshi & X. Y. Wang 0910401 (KoLRI).

REMARKS — Other closely similar usnic acid containing South Korean species with which *L. leuckertiana* might be confused are *L. coriensis* and *L. texta*. Distinctly lobed thallus margins with raised rims and presence of constipatic acid diagnose *L. coriensis*, while the lack of medulla and presence of whitish hypothallus distinguishes *L. texta*.

10. *Lepraria lobata* Elix & Kalb, Mycotaxon 94: 220, 2006 [“2005”]

DIAGNOSTIC CHARACTERS — Thallus leprose, granular, bluish gray, margin delimited, forming thin to thick \pm continuous extensive irregularly spreading patches. Margins with sublobes 0.2–0.7 mm wide. Soredia sparse to abundant, dispersed or forming a thick continuous layer, fine to coarse, 20–60 μ m in diam., aggregated in \pm rounded consoredia up to 300 μ m diam., projecting hyphae present, long, up to 100 μ m long. Medulla present, conspicuous, white. Hypothallus absent. For further descriptions see Elix (2006a).

CHEMISTRY — Spot test reactions: thallus K+ yellow, C–, KC–, P+ pale yellow. Secondary metabolites: Atranorin, Zeorin and a fatty acid (roccellic/angardianic acid).

ECOLOGY — At the collection site (494 m), the species was found growing over bark.

GEOGRAPHICAL DISTRIBUTION — Australia (Saag et al. 2009); new to East Asia (South Korea).

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Baekseok bong, N37°28'739" E128°39'760", alt. 494 m, on bark, 16 May 2009, Hur 090456, 090462 (KoLRI).

REMARKS — The similar *L. pallida*, another South Korean lepraria containing atranorin and zeorin, can be differentiated from *L. lobata* by its gray to black hypothallus and an unidentified fatty acid. *Lepraria lobata* lacks a hypothallus and has roccellic/angardianic fatty acid.

11. *Lepraria lobificans* Nyl., Flora 56: 196, 1873

DIAGNOSTIC CHARACTERS — Thallus leprose, cottony to rarely powdery, bluish gray to greenish gray, margin diffuse to rarely delimited, forming thin to thick \pm continuous extensive irregularly spreading patches, or sometimes becoming partly detached from the thallus. Margins sometimes with delimited sublobes 0.5–1.0 mm wide. Soredia abundant, dispersed or forming a thick continuous layer, fine to coarse, 20–60 μ m in diam., commonly aggregated in \pm round consoredia up to 300 μ m diam., projecting hyphae present, long, up to 100 μ m long. Medulla present, conspicuous, white. Hypothallus rarely present, scarce, pale brown. For further descriptions see Laundon (1992) and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K–, C–, KC–, P+ pale orange. Secondary metabolites: Atranorin, Zeorin and Stictic acid complex.

ECOLOGY — At the collection site (630 m), the species was found growing on soil over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — Cosmopolitan (Saag et al. 2009); new to South Korea.

SPECIMEN EXAMINED — South Korea: Kangwon Prov.: Mt. Hwangbyong, N37°44'41.3" E128°37'31.0", alt. 630 m, on soil over rocks, 14 July 2008, Hur 080352 (KoLRI).

REMARKS — *Lepraria leprolomopsis* and *L. caesioalba* var. *caesioalba* are the other atranorin and stictic acid complex containing South Korean species. A yellowish thallus, harder, medium sized to coarse (75–110 µm diam.) soredia with or without short projecting hyphae separates *L. leprolomopsis* from *L. lobificans*, while the absence of medullary hyphae distinguishes *L. caesioalba* var. *caesioalba*.

12. *Lepraria membranacea* (Dicks.) Vain., Acta Soc. Fauna Flora Fennica 49(2): 265, 1921

DIAGNOSTIC CHARACTERS — Thallus crustose to squamulose to subfoliose, leprose, membranous, pale yellow gray to yellow-white, consisting of powdery lobes, forming irregular rosettes. Margins delimited. Lobes present, well developed, up to 2 mm long and wide, with a raised rim. Soredia abundant, sometimes not well separated at margin, fine to coarse, 40–65 µm in diam., commonly aggregated in ±round consoredia up to 130–210 µm diam., projecting hyphae sometimes present, short. Medulla present, conspicuous, white. Hypothallus present, well developed, dark, sometimes white along margins. For further descriptions see Laundon (1989) and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K+ yellow, C–, KC–, P+ reddish orange. Secondary metabolites: Pannaric acid, atranorin (in traces).

ECOLOGY — At the collection site (770 m), the species was found growing over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — Cosmopolitan (Saag et al. 2009); new to South Korea.

SPECIMEN EXAMINED — South Korea: Chongchung Prov.: Mt. Gyeryong, N36°21'25.6", E127°12'35.3", alt. 770 m, on rock, 23 October 2004, Hur 041632 (KoLRI).

REMARKS — *Lepraria diffusa* and *L. vouauxii* are the other dibenzofuran producing South Korean species with which *L. membranacea* might be confused. However, *L. membranacea* has pannaric acid as its major secondary compound separating it from *L. diffusa* with 4-oxypannaric acid 2-methylester as the only major dibenzofuran and *L. vouauxii* with pannaric acid 6-methylester as the major dibenzofuran.

13. *Lepraria neglecta* (Nyl.) Erichsen, Flechtenflora von Nordwestdeutschland: 394, 1957

DIAGNOSTIC CHARACTERS — Thallus leprose, granular, whitish gray to bluish gray to yellowish gray, margins diffuse or weakly delimited, forming \pm regular rosettes or irregular patches, firmly attached to the substratum. True lobes absent, obscure sublobes present. Soredia abundant, coarse, 100–130(–200) μ m in diam., commonly aggregated in \pm round consoredia up to 200–300 μ m diam., projecting hyphae usually absent. Medulla sometimes present, inconspicuous. Hypothallus sometimes present, poorly developed, gray to brown. For further descriptions see Laundon (1992) and Elix (2009).

CHEMISTRY — Spot test reactions: thallus K+ yellow, C– or + orange-red, KC+ orange-red, P+ lemon yellow or orange. Secondary metabolites: Alectorialic acid and a fatty acid (roccellic/angardianic acid).

ECOLOGY — *Lepraria neglecta*, one of the most common *Lepraria* species in South Korea, has been found growing on bark and soil over rocks between elevations of 300–706 m.

GEOGRAPHICAL DISTRIBUTION — Widely distributed throughout Europe, North and South America, Asia, Australasia, Antarctica, Greenland (Saag et al. 2009); new to South Korea.

SPECIMENS EXAMINED – South Korea: Jeollanam Prov.: Jangheung Co., Mt. Cheongwan, N34°32'09.1" E126°55'32.3", alt. 450 m, on *Pinus densiflora*, 07 October 2005, L. Lökös 050651 (KoLRI); Jeollanam Prov.: Mt. Cheongwan, N34°32'33.1" E126°55'46.7", alt. 300 m, on bark, 07 October 2005, Hur 050543 (KoLRI); Jeollanam Prov.: Mt. Cheongwan, N34°32'33.1" E126°55'46.7", alt. 300 m, on soil over rock, 07 October 2005, Hur 050545 (KoLRI); Kangwon Prov.: Dongbalam valley, N37°51'692" E128°31'522", alt. 706 m, on soil over rock, 23 May 2009, Y. Joshi & X. Y. Wang 090730-2 (KoLRI).

REMARKS — *Lepraria eburnea*, another alectorialic acid containing South Korean species, differs in having a soft thallus with a distinct medulla and loosely packed soredia. The thallus of *L. neglecta* is hard and granular with an inconspicuous medulla and densely packed soredia.

14. *Lepraria pallida* Sipman, Herzogia 17: 33, 2004

DIAGNOSTIC CHARACTERS — Thallus leprose, granular to partly membranous, whitish gray to bluish gray, forming \pm regular rosettes or irregular patches, loosely attached to the substratum. Margins usually delimited. Lobes present in places, usually well developed (0.5–2.0 mm wide and long) with \pm raised marginal rim. Soredia abundant, sometimes not well separated from each other, medium sized up to 100 μ m in diam., projecting hyphae absent. Medulla present, white. Hypothallus present, tomentose, gray to black. For further descriptions see Sipman (2004).

CHEMISTRY — Spot test reactions: thallus K⁺ pale yellow, C[–], KC[–], P[–] or pale yellow to yellow-orange. Secondary metabolites: Atranorin and Zeorin in majority, unidentified fatty acids (minor).

ECOLOGY — *Lepraria pallida*, one of the most common *Lepraria* species in South Korea, has been found growing over both bark and non-calcareous rocks between elevations of 410–1265 m.

GEOGRAPHICAL DISTRIBUTION — South America and Africa (Saag et al. 2009); new to East Asia (South Korea).

SPECIMENS EXAMINED – South Korea: Jeollanam Prov.: N35°19'09.7" E127°44'31.4", alt. 1265 m, on rocks, 15 November 2006, Hur 060652 (KoLRI); Kyongsangnam Prov.: Mt. Cheontae, N36°09'26.6" E127°36'22.7", alt. 542 m, on rock, 03 November 2006, Hur 061190 (KoLRI); Kyongsangnam Prov.: Mt. Worak, N36°52'55.5" E128°06'35.8", alt. 990 m, on soil over rocks, 19 September 2004, Hur 041235 (KoLRI); Kyongsangnam Prov.: Mt. Gaya, N35°48'11.9" E128°08'35.0", alt. 500 m, on soil over rocks, 05 May 2006, Hur 060090 (KoLRI); Chungchongbuk Prov.: Mt. Songni, N36°32'06.6" E127°50'42.5", alt. 410 m, on *Pinus* bark, 21 April 2006, Hur 0600039 (KoLRI); Kangwon Prov.: Mt. Seorak, N38°09'981" E128°27'267", alt. 463 m, on soil over rocks, 24 May 2009, Y. Joshi & X. Y. Wang 090815 (KoLRI); Kangwon Prov.: Gitdae bong, N37°18'367" E128°56'766", alt. 1222 m, on soil over rocks, 15 May 2009, Y. Joshi & X. Y. Wang 090403 (KoLRI).

REMARKS— *Lepraria lobata* is another atranorin, zeorin and fatty acid containing South Korean species with which *L. pallida* is likely to be confused. Lack of hypothallus and presence of roccellic/angardianic acid separate *L. lobata* from *L. pallida*, which always has a gray to black hypothallus and unidentified fatty acids.

15. *Lepraria texta* K. Knudsen, Elix & Lendemer, Lichen Flora of Greater Sonoran Desert Region Vol. 3: 387, 2008

DIAGNOSTIC CHARACTERS — Thallus leprose, powdery, yellow green to greenish gray, forming thin to thick ±continuous extensive irregularly spreading patches, or sometimes forming ±rounded colonies. Margins not delimited. Lobes absent. Soredia abundant, dispersed or forming a thick continuous layer, not well separated from each other, fine, up to 50 µm in diam., projecting hyphae present, short. Medulla absent. Hypothallus sometimes present, conspicuous, white. For further descriptions see Knudsen & Elix (2008).

CHEMISTRY — Spot test reactions: thallus K[±] yellow, C[–], KC[–], P[–]. Secondary metabolites: Usnic acid, Zeorin, Atranorin.

ECOLOGY — At the collection site (1104 m), the species was found growing over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — North America (Saag et al. 2009); new to Asia (South Korea).

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Galjeongok bong, N37°52'952" E128°30'161", alt. 1104 m, on rocks, 22 May 2009, Y. Joshi & X. Y. Wang 090583 (KoLRI).

REMARKS — *Lepraria texta* might be confused with two other usnic acid containing South Korean species, *L. coriensis* and *L. leuckertiana*. Distinctly lobed thallus margins with raised rims and presence of constipatic acid distinguish *L. coriensis*, and the presence of thick and cottony medulla characterises *L. leuckertiana*.

16. *Lepraria vouauxii* (Hue) R.C. Harris, Bryologist 90: 163, 1987

DIAGNOSTIC CHARACTERS — Thallus leprose, cottony to powdery, yellowish gray, margins diffuse to weakly delimited, forming ±regular rosettes or irregular patches, firmly attached to the substratum. True lobes absent, obscure lobes present, without raised rims. Soredia abundant, coarse, up to 100 µm in diam., aggregated in ±round consoredia up to 300 µm diam. Medulla present, thick, white, often exposed between soredia. Hypothallus present, brownish. For further descriptions see Laundon (1989) and Tønsberg (2004).

CHEMISTRY — Spot test reactions: thallus K+ faint yellow, C–, KC–, P–. Secondary metabolites: Pannaric acid 6-methylester, Atranorin and Zeorin.

ECOLOGY — At the collection site (1192 m), the species was found growing over soil on rocks.

GEOGRAPHICAL DISTRIBUTION — Cosmopolitan (Saag et al. 2009); new to South Korea.

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Dongbalam valley, N37°51'359", E128°30'974", alt. 1192 m, on rocks, 23 May 2009, Y. Joshi & X. Y. Wang 090672-1 (KoLRI).

REMARKS — *Lepraria vouauxii* is often confused with two other dibenzofuran producing South Korean species, *L. diffusa* and *L. membranacea*. *Lepraria diffusa* has 4-oxypannaric acid 2-methylester as only major dibenzofuran, while *L. membranacea* differs in producing pannaric acid as major substance. *Lepraria vouauxii*, on the other hand, contains large quantities of pannaric acid 6-methylester.

17. *Lepraria xerophila* Tønsberg, Lichen Flora of Greater Sonoran Desert Region Vol. 2: 328, 2004

DIAGNOSTIC CHARACTERS — Thallus crustose to squamulose to subfoliose, membranous, pale yellow-gray to yellow-white, determinate, forming ±irregular patches. Margins delimited, obscurely lobed, lobes up to 2 mm long and wide, with ±raised rim. Soredia few or absent, numerous large granules similar to

isidia are present. Medulla present, conspicuous, white. Hypothallus absent. For further descriptions see Tønsberg (2004).

CHEMISTRY — Spot test reactions: thallus K–, C–, KC–, P–. Secondary metabolites: Norascomatic acid (Chemotype 2). It is the rarest chemotype of this species.

The common chemotype of this species is Chemotype 1, which contains pannaric acid 6-methylester, rangiformic and/or roccellic acid, atranorin, methyl porphyrilate, porphyrilic acid, pannaric acid, and an unknown dibenzofuran (Tønsberg 2004, Elix & Tønsberg 2004).

ECOLOGY — At the collection site (1101 m), the species was found growing over non-calcareous rocks.

GEOGRAPHICAL DISTRIBUTION — Europe and North America (Saag et al. 2009); new to Asia (South Korea).

SPECIMEN EXAMINED – South Korea: Kangwon Prov.: Galjeongok bong, N37°52'880", E128°26'849", alt. 1101 m, on rocks, 22 May 2009, Y. Joshi & X. Y. Wang 090637 (KoLRI).

REMARKS — So far *Lepraria xerophila* is the only South Korean norascomatic acid containing species and thus easily separated from other Korean species.

Acknowledgments

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Literature cited

- Aptroot A, Diederich P, Sérusiaux E, Sipman HJM. 1997. Lichens and lichenicolous fungi from New Guinea. *Bibliotheca Lichenologica* 64: 1–220.
- Bayerová Š, Kukwa M, Fehrer J. 2005. A new species of *Lepraria* (lichenized *Ascomycetes*) from Europe. *Bryologist* 108: 131–138.
- Crespo A, Arguello A, Lumbsch HT, Llimona X, Tønsberg T. 2006. A new species of *Lepraria* (Lecanorales: *Stereocaulaceae*) from the Canary Islands and the typification of *Lepraria isidiata*. *Lichenologist* 38: 213–221.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125.
- Ekman S, Tønsberg T. 2002. Most species of *Lepraria* and *Leproloma* form a monophyletic group closely related to *Stereocaulon*. *Mycological Research* 106: 1262–1276.
- Elix JA. 2006a [“2005”]. New species of sterile crustose lichens from Australasia. *Mycotaxon* 94: 219–224.

- Elix JA. 2006b. The chemical diversity of *Lepraria coriensis* and *L. usnica* (lichenized *Ascomycota*) in Australia. *Australasian Lichenology* 58: 24–26.
- Elix JA. 2009. *Stereocaulaceae*. In: McCarthy, PM (ed.) *Flora of Australia*, Vol. 57, Lichens 5. Canberra & Melbourne: ABRS and CSIRO Publishing, pp. 60–73.
- Elix JA, Kalb K. 2008. Additional new lichen taxa (lichenized *Ascomycota*) from Australia. *Australasian Lichenology* 63: 30–36.
- Elix JA, Tønsberg T. 2004. Notes on the chemistry of some lichens, including four species of *Lepraria*. *Graphis Scripta* 16: 43–45.
- Elix JA, Johnston J, Parker JL. 1987. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances. Second edition. Australian National University, Canberra, pp. 1–103
- Harada H, Okamoto T, Yoshimura I. 2004. A checklist of lichens and lichen-allies of Japan. *Lichenology* 2: 47–165.
- Hue AM. 1924. Monographia *Crocyniarum*. *Bulletin de la Société Botanique de France* 71: 311–402.
- Hur JS, Koh YJ, Harada H. 2005. A checklist of Korean lichens. *Lichenology* 4: 65–95.
- Kim S. 1981. Floral studies on the lichens in Korea. *Bulletin of Kongju Teachers College* 17: 279–305.
- Knudsen K, Elix JA. 2008. Additional species: *Lepraria*. In: Nash III TH, Gries C, Bungartz F (eds.) *Lichen Flora of the Greater Sonoran Desert Region*, Vol. 3. pp. 384–388. Tempe, Arizona: Lichens Unlimited, Arizona State University.
- Kukwa M. 2006. The lichen genus *Lepraria* in Poland. *Lichenologist* 38: 293–305.
- Kukwa M, Flakus A. 2009. *Lepraria glaucosorediata* sp. nov. (*Stereocaulaceae*, lichenized *Ascomycota*) and other interesting records of *Lepraria*. *Mycotaxon* 108: 353–364.
- Laundon JR. 1989. The species of *Leproloma* – the name for the *Lepraria membranacea* group. *Lichenologist* 21: 1–22.
- Laundon JR. 1992. *Lepraria* in the British Isles. *Lichenologist* 24: 315–350.
- Laundon JR. 2003. Six lichens of the *Lecanora varia* group. *Nova Hedwigia* 76: 83–111.
- Lendemer JC. 2005. Lichens of Eastern North America Exsiccati. Fascicle IV, nos. 151–200. *Opuscula Philolichenum* 2: 37–52.
- Leuckert C, Kümmerling H, Wirth V. 1995. Chemotaxonomy of *Lepraria* Ach. and *Leproloma* Nyl. ex Crombie, with particular reference to Central Europe. *Bibliotheca Lichenologica*: 58: 245–259.
- Lohtander K. 1994. The genus *Lepraria* in Finland. *Annales Botanici Fennici* 31: 223–231.
- Moon KH. 1999. Lichens of Mt. Sorak in Korea. *Journal of the Hattori Botanical Laboratory* 86: 187–220.
- Orange A. 1997. Chemical variation in *Lepraria eburnea*. *Lichenologist* 29: 9–13.
- Saag L, Hansen ES, Saag A, Randlane T. 2007. Survey of *Lepraria* and *Leprocaulon* in Greenland. *Mycotaxon* 102: 57–90.
- Saag L, Saag A, Randlane T. 2009. World survey of the genus *Lepraria* (*Stereocaulaceae*, lichenized *Ascomycota*). *Lichenologist* 41: 25–60.
- Sipman HJM. 2004. Survey of *Lepraria* species with lobed thallus margins in the tropics [Übersicht der *Lepraria*-Arten mit gelappten Thallusrändern in den Tropen]. *Herzogia* 17: 23–35.
- Slavíková-Bayerová Š, Orange A. 2006. Three new species of *Lepraria* (*Ascomycota*, *Stereocaulaceae*) containing fatty acids and atranorin. *Lichenologist* 38: 503–513.
- Sato M. 1943. *Index plantarum Nipponicarum IV, Lichenes*. Tokyo: Tokyo Science Museum.

- Tønsberg T. 1992. The soresdiate and isidiate, corticolous, crustose lichens in Norway. *Sommerfeltia* 14: 1–331.
- Tønsberg T. 2004. *Lepraria*. In: Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (eds.) *Lichen Flora of the Greater Sonoran Desert Region*, Vol. 2. pp. 322–329. Tempe, Arizona: Lichens Unlimited, Arizona State University.
- Wei JC. 1991. An enumeration of lichens in China. International Academic Publishers, China.
- White FJ, James PW. 1985. A revised guide to the microchemical techniques for the identification of lichen substances. *British Lichen Society Bulletin* 57 (Supplement): 1–41.
- Wirth V, Düll R, Llimona X, Ros RM, Werner O. 2004. *Guia de Campo de los Líquenes, Musgos y Hepaticas*. Barcelona: Ediciones Omega.
- Zedda L. 2000. *Lecanora leuckertiana* sp. nov. (lichenized *Ascomycetes*, *Lecanorales*) from Italy, Greece, Morocco and Spain. *Nova Hedwigia* 71: 107–112.

***Symphaster ximeniae* sp. nov.: a rare asterinaceous fungus from Brazil**

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Abstract — A new asterinaceous fungus collected on *Ximenia americana* is described from Northeastern Brazil and named *Symphaster ximeniae*.

Key words — *Asterinaceae*, *Olacaceae*, systematics

Introduction

Among the 46 genera of *Asterinaceae* Hansf. recently listed (Kirk et al. 2008), *Symphaster* Theiss. & Syd. (Theissen & Sydow 1915: 217) has the smallest number of species. It comprises only two species: the type species *S. gesneriaceae* (Henn.) Theiss. & Syd. (basionym *Cocconia gesneriaceae* Henn.), and *S. areolata* (Doidge) Arx (basionym *Isipinga areolata* Doidge). The first species was observed in Rio de Janeiro, Brazil, by Hennings (1904: 91) on leaves of an unknown *Gesneriaceae* plant, and since then no other registers of specimens of this fungus have been made, indicating its rare condition. The second species was found on *Euclea natalensis* A. DC. (*Ebenaceae*) in South Africa (Doidge 1921: 15).

Many epiphytic fungi have been described on leaves of *Ximenia americana* L. (*Olacaceae*), mainly *Meliolales* (Viégas 1961, Silva & Minter 1995, Mendes et al. 1998), but no *Symphaster* species has been registered. Similarly, new *Asterina* species have been recorded in recent years (Hosagoudar et al. 2001a; Hofmann & Piepenbring 2008; Song 2003; Song & Li 2002, 2004; Song et al. 2003a,b, 2004), but no new *Symphaster* species.

During the past few decades, Müller & Arx (1962) and Arx & Müller (1975) added new information about *Symphaster* and in this century Hosagoudar et al.

(2001b) and Bezerra (2004) made new contributions. The family *Asterinaceae* has been well characterized by Müller & Arx (1962), Lutrell (1973), Arx & Müller (1975), Barr (1987), Hosagoudar et al. (2001b), and Bezerra (2004).

As occurs with other biotrophic pathogens in *Asterinaceae*, *Symphaster* species are apparently host specific. In this case, not only morphological characters but also the host plant may be useful to separate species. Considering the low number of records of the genus, however, host specificity should be confirmed. For Hofmann & Piepenbring (2008), induction of plant infection and DNA sequence data may help elucidate this question for this family.

During a survey of *Asterinaceae* in a tropical forest in Brazil, a fungus with characteristics of *Symphaster* was found and is now described as a new species.

Materials and methods

Leaves of *Ximenia americana* (local name: Limão; Ameixeira-do-Brasil) showing superficial black stromata of an asterinaceous fungus were collected in October 2006 in the “Reserva Ecológica de Dois Irmãos”, a remnant of Atlantic Rain Forest, in the municipality of Recife, State of Pernambuco, Brazil. The aspect of the colonies on the leaf was observed on a stereomicroscope and the adhesive transparent tape method was used to visualize hyphae and hyphopodia. Free hand sections and squash mounts stained with lactophenol cotton blue were used to study the morphology of the fungus under the light microscope. The structures were measured in water. An exsiccatum of the material was deposited in the mycological collection of URM Herbarium and Mycobank number for new species was cited.

Taxonomy

Symphaster ximeniae J.L. Bezerra, Drechsler-Santos & Jad. Pereira, **sp. nov.**

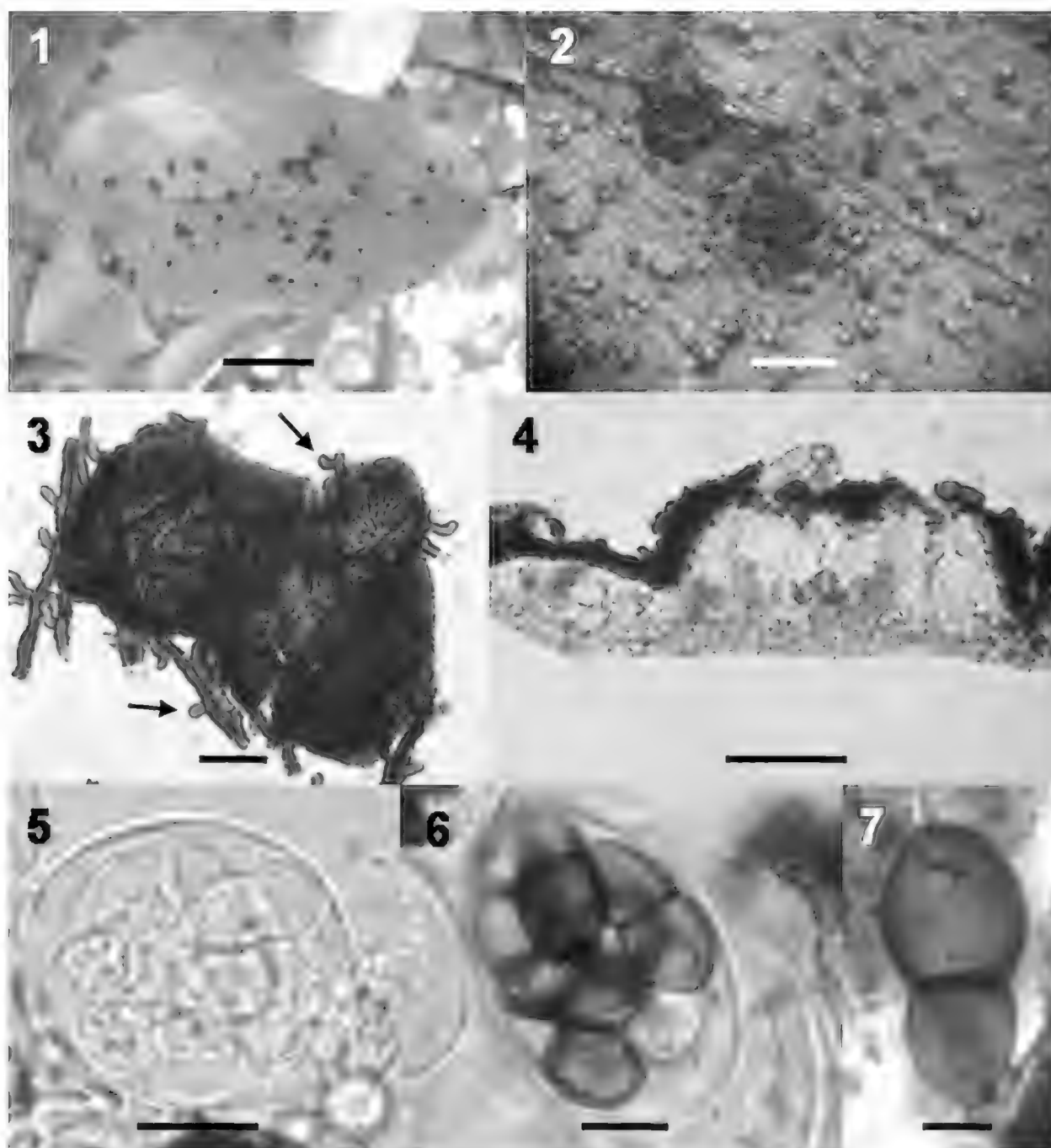
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FIGS. 1–7

Coloniae epyphyllae vel amphigenae, densae, dispersae vel confluentes, 1–4 mm diam. *Hyphae* flexuosae, brunneae, septatae, hyphopodiatæ, ramosae, cellulis 16–20 × 5–6 µm. *Hyphopodia* unicellularia, brunnea obovata vel oblonga, recta vel incurvata, alternata vel opposita, integra, cellulis, 8–13 × 5.5–7 µm. *Haustoriae* intraepidermale, hyalinae. *Thyriothecia* ad 60–200 µm diam, confluentes, multilocullata, rotunda vel irregulariter, stellato dehiscentes ad centre, margine crenata; asci 38–52 × 23–32 µm, octosporae, globosae, bitunicatae, sessilia; paraphysoides mucosae praeditae; ascosporae 21–25 × (6–)7–10(–14) µm, ellipsoideae, brunneae, bicellulatae, fortiter constrictae, submedianae septae, parietus glabrae vel leniter espinescentis.

TYPE: BRAZIL: Pernambuco, Recife, Reserva Ecológica de Dois Irmãos (08°00'39.1"S and 34°56'38.8"W, 10m alt.), 12.X.2006, leg. J.L. Bezerra and E.R. Drechsler-Santos, on living leaves of *Ximenia americana* (**HOLOTYPE**, URM 79224).

ETYMOLOGY: derived from the host genus *Ximenia*.



FIGS. 1–7. *Symphaster ximeniae*. 1–2. A leaf of *Ximenia americana* showing epiphyllous colonies. 3. Young ascomata with hyphopodiate hyphae (arrows) 4. Vertical section of ascoma. 5. Young bitunicate ascus. 6. Ascus with mature ascospores. 7. Ascospore with septum below the middle.
Scale bars: 1 = 5 mm; 2 = 1 mm; 3, 4 = 50 μ m; 5 = 20 μ m; 6 = 10 μ m; 7 = 5 μ m.

Colonies dull black, amphigenous, mostly epiphyllous, crustose, subcircular to irregular, isolate or confluent, scattered, 1–4 mm diam. Mycelium superficial of flexuous, brown, septate, hyphopodiate, oppositely or unilaterally branched, teleomorphic hyphae 16–20 \times 5–6 μ m. Hyphopodia unicellular, brown concolorous with the hyphae, obovoid to oblong or cylindrical, straight or curved, opposite or alternate, entire, 8–13 \times 5.5–7 μ m. Haustoria coralloid, hyaline, intra-epidermical. Ascomata dark brown, round to irregular, scutate, confluent, 60–200 μ m diam, forming stromatic multilocular crusts; upper wall,

opaque dark brown, 8–17 μm thick, formed of radiating rectangular cells, 6–12 \times 3–5 μm diam, opening by stellate dehiscence. Basal wall, 10–17 μm thick, formed by hyaline, thin walled hyphal cells. Paraphysoids numerous, in gelatinous mass, hyaline, filiform, septate, 2–3 μm diam. Asci 8-spored, globose to subglobose, sessile, thick walled, bitunicate, not bluing in Melzer's reagent, 38–52 \times 23–32 μm . Ascospores 1-septate below the middle, constricted in the septum, oblong, with rotund ends, brown at maturity, smooth to slightly rough, 21–25 \times (6–)7–10(–14) μm , with a larger apical cell.

NOTES: *Symphaster ximeniae* differs from *S. gesneriaceae* and *S. areolata* by possessing globose to subglobose asci and smaller ascospores, which are septate below the middle. *Symphaster areolata* and *S. gesneriaceae* differ from each other in ascospore size and type of hyphopodia. Authentic material of *S. areolata* (URM 23061 = PRE 22362) was examined, but no ascoma was seen. Each of the three *Symphaster* species occurs on a different host family.

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References

- Arx JA von, Müller E. 1975. A re-evaluation of the bitunicate ascomycetes with keys to families and genera. *Stud Mycol* 9: 1–160.
- Barr ME. 1987. *Prodromus to Class Loculoascomycetes*. Lubrecht & Cramer, Forestburg
- Bezerra JL. 2004. Taxonomia de Ascomycetos. Ordem Asterinales. *Revisão Anual de Patologia de Plantas* 11: 15–28.
- Doidge EM. 1921. South African ascomycetes in the National Herbarium I. *Bothalia* 1: 5–32.
- Hennings P. 1904. *Fungi fluminenses a cl. E. Ule collecti*. *Hedwigia* 43: 78–95.
- Hofmann TA, Piepenbring M. 2008. New species and records of *Asterina* from Panama. *Mycol. Progress* 7: 87–98.
- Hosagoudar VB, Abraham TK, Biju, CK, Hyde KD. 2001a. Fungi from palms. XLVII. A new species of *Asterina* on palms in India. *Fungal Diversity* 6: 69–73.
- Hosagoudar VB, Abraham TK, Biju CK. 2001b. Re-evaluation of the family *Asterinaceae*. *Journal of Mycopathological Research* 39: 61–63.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. *Ainsworth and Bisby's dictionary of the fungi*. 10th ed. CABI International. Wallingford, UK.
- Luttrell ES. 1973. *Loculoascomycetes*. In: Ainsworth GC, Sparrow FK, Sussman AS (eds.). *The Fungi*. vol. IV A. Academic Press, New York, pp 135–219.
- Mendes MAS, Silva VL, Dianese JC, et al. 1998. *Fungos em plantas no Brasil*. Embrapa-SPI/Embrapa-Cenargen, Brasília.

- Müller E, Arx JA von. 1962. Die Gattungen der didymosporen Pyrenomyceten. Beitr. Kryptogfl. Schwz 11(2). 922 p.
- Silva MS, Minter D. 1995. Fungi from Brazil recorded by Batista and co-workers. CAB International, Mycological Papers 169.
- Song B. 2003. New species of the genus *Asterina* from China III. Mycotaxon 85: 319–324.
- Song B, Li TH. 2002. New species of the genus *Asterina* from China, Mycotaxon 84: 407–412.
- Song B, Li TH. 2004. New species of *Asterina* in HMAS, China. Mycotaxon 89: 193–199.
- Song B, Li TH, Hosagoudar VB. 2003a. Four new *Asterina* species from Yunnan, China. Fungal Diversity 14: 157–164.
- Song B, Li TH, Shen YH. 2003b. Two new *Asterina* species from Hainan, China. Mycotaxon 87: 417 – 419.
- Song B, Li TH, Shen YH. 2004. New species of *Asterina* from Guangdong, China. Mycotaxon 90: 29–34.
- Theissen F, Sydow H. 1915. Die *Dothideales*. Kritisch-systematische Originaluntersuchungen, Ann. Mycol. 13: 149–746.
- Viégas AP. 1961. Índice de fungos da América do Sul. Instituto Agronômico, Campinas.

***Clitopilus byssisedoides*, a new species from a hothouse in Germany**

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Abstract — *Clitopilus byssisedoides* is described as a new species found in a hothouse in Botanischer Garten Jena, in Jena, Germany, of unknown, possibly tropical origin. In this study, it is described, illustrated and distinguished from other pleurotoid *Clitopilus* species with rhodocyboid spores, particularly from other members of (*Rhodocybe*) sect. *Claudopodes*

Key words — *Entolomataceae*, phylogeny, taxonomy

Introduction

Gminder (2005) described a remarkable pleurotoid species with rhodocyboid spores from a hothouse in the botanical garden in Jena, Germany. It was provisionally called “*Rhodocybe byssisedoides*” because of its resemblance to *Entoloma byssisedum* (Pers.) Donk. In a recent molecular phylogenetic study of the *Entolomataceae* (where this new species was included as “*Rhodocybe* sp.”), it has been shown that *Clitopilus* is nested within *Rhodocybe*. As a result, both genera were merged into *Clitopilus sensu lato* (Co-David et al. 2009). In this study, we formally describe the new species, *Clitopilus byssisedoides* and compare it to the other pleurotoid taxa.

Material and methods

The morphology was studied on dried material with standard methods, using sections mounted in either ammonia 5% or Congo red and a Leica DM1000 microscope. Microscopic structures were drawn with help of a drawing tube.

Taxonomic description

Clitopilus byssisedoides Gminder, Noordel. & Co-David, sp. nov.

MYCOBANK # 515443

FIG. 1, PLATE 1.

Basidiocarpia pleurotoidea ad 20 mm lata cinerescens incarnate hygrophanea glabra, lamellae modice distantes cremeo cinereae ochrascentes, sporae 5.5–7 µm longae 4–4.5 µm latae pustulatae vel leniter angulares lateraliter visu, pseudocystidia fibulaeque desunt. Ligno putrescente in olla cum *Phalaenopsis* sp. in caldaria tropica.

HOLOTYPE: Germania, Jena, 27.IV.2004, A. Gminder (L), isotypus in herbario Gminder sub numero 20040050.

ETYMOLOGY: *byssisedoides* = referring to the resemblance to *Entoloma byssisedum*.

MACROCHARACTERS — Basidiocarps pleurotoid, dorsally attached to its substratum with distinct rhizomorphs. Pileus up to 20 mm broad, conchate/shell-shaped with undulating involute margin, grayish incarnate, hygrophanous, translucently striate, glabrous. Lamellae moderately distant, rather distant creamy-grey turning dark ochre with age. Stipe lacking. Context very thin, watery grayish cream.

MICROCHARACTERS — Spores 5.5–7 × 4–4.5 µm, Q = 1.3.5–1.55–1.65, elliptical to pip-shaped, slightly thick-walled, pustulate, in profile weakly angular under a light microscope, strongly cyanophilous. Basidia 15–32 × 5–9 µm, 4-spored. Lamella edge fertile, cystidia absent, pseudocystidia absent. Pileipellis a compact cutis of narrow (2–6 µm wide), cylindrical hyphae, gradually passing into pileitrama with incrustated pigment. Pileitrama regular, made up of 4–12 µm wide, cylindrical hyphae. Clamp-connections absent.

HABITAT — On decayed wood in pot with *Phalaenopsis* (Orchidaceae) in a tropical hothouse.

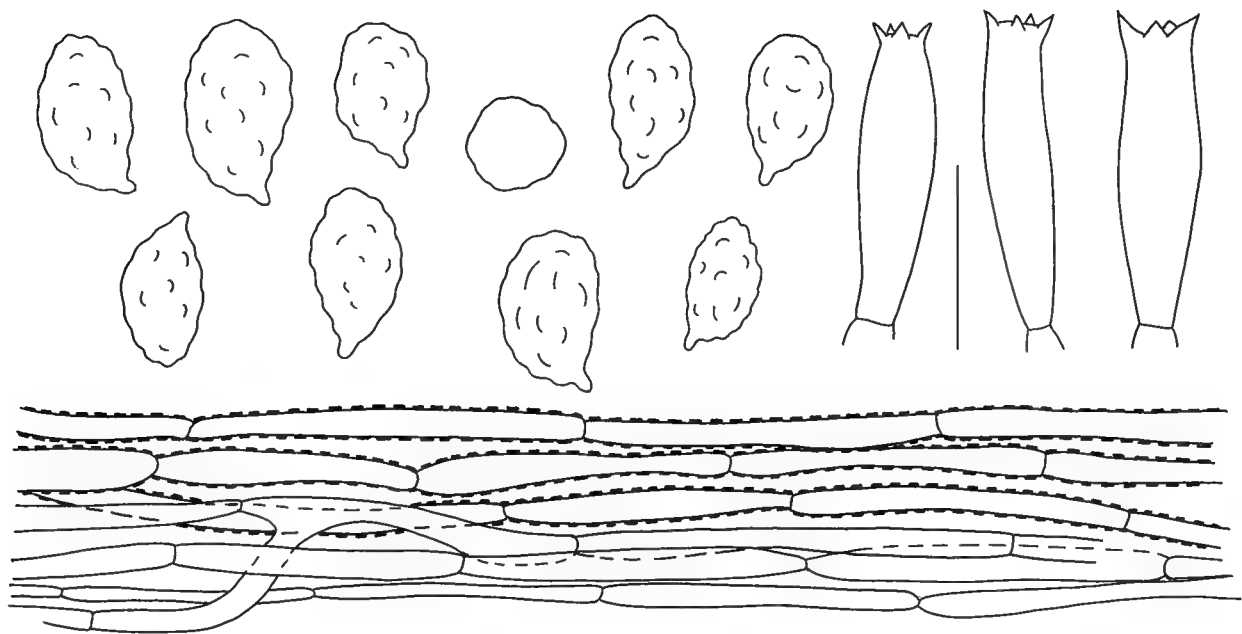


FIG. 1. *Clitopilus byssisedoides*. Spores, basidia, and pileipellis (holotype). Bar = 10 µm

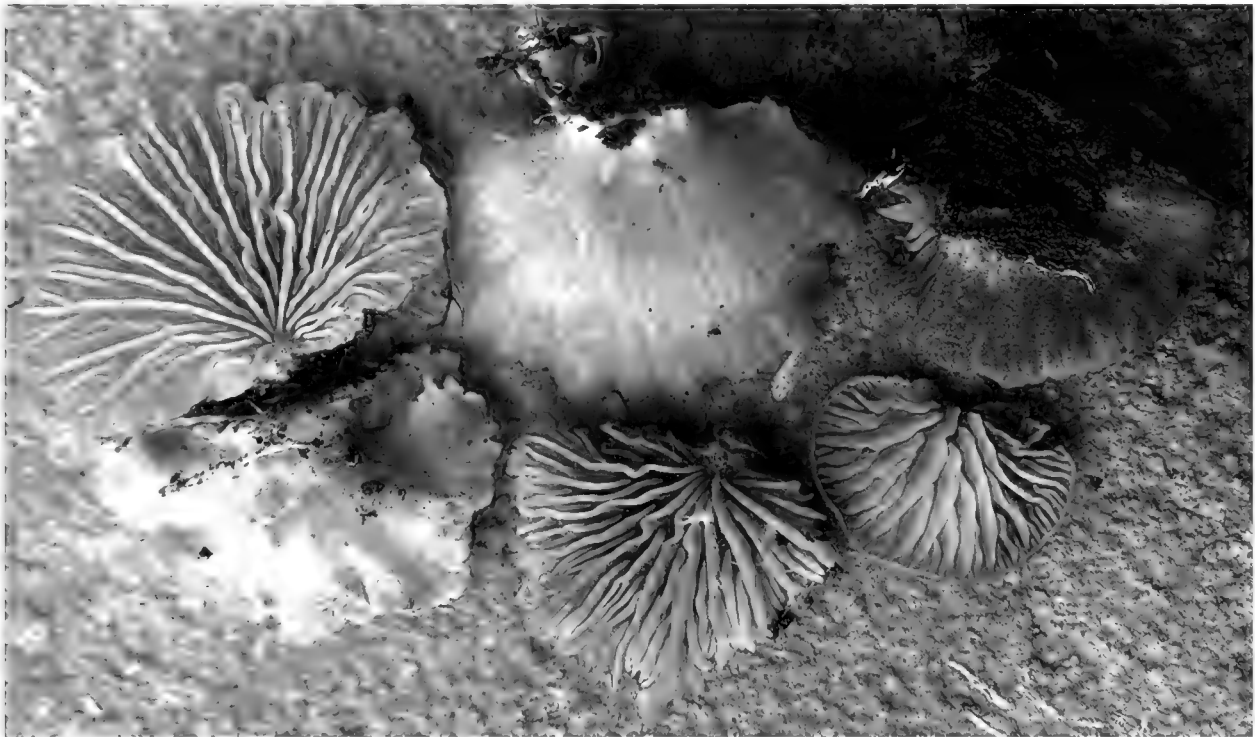


PLATE 1. *Clitopilus byssisedoides*. Habit (holotype). Photo A. Gminder.

COMMENTS — *Clitopilus byssisedoides* is remarkable because there are only a few pleurotoid species of *Clitopilus* with rhodocyboid spores that have been described, and most of them are only known from their type locality.

This new species fits well in (*Rhodocybe*) section *Claudopodes* Singer ex T.J. Baroni (Baroni 1981), the section containing species with stipe either absent or laterally placed and with pseudocystidia with brightly colored content absent.

Since it is likely of tropical origin, *C. byssisedoides* is compared with all known pleurotoid, rhodocyboid-spored *Clitopilus* species. It can be distinguished as follows: *Clitopilus claudopus* (Singer ex T.J. Baroni) Noordel. & Co-David, known from Argentina, has a yellowish brown, cracked-rimose pileus, well-developed eccentric stipe, and short, globose to subglobose spores (Baroni 1981). *Clitopilus pleurogenus* (Pegler) Noordel. & Co-David from Tanzania is described with an ash grey pileus, and short, globose spores (Pegler 1977). *Clitopilus rhizogenus* (T.J. Baroni & E. Horak) Noordel. & Co-David from the USA differs by its pale argillaceous to pale brownish-orange, fibrillose, estriate pileus, well-developed, central to eccentric stipe, and well-developed cheilocystidia (Baroni & Horak 1994). *Clitopilus paurii* (T.J. Baroni, et al.) Noordel. & Co-David from India, differs by its much darker colour, tomentose pileus, and small subglobose spores (Moncalvo et al. 2004). *Clitopilus crystallinus* (T.J. Baroni) Noordel. & Co-David from Venezuela is a white, dimidiate species with densely tomentose pileal surface (Baroni & Horak 1994). Two species described by Horak also differ considerably from our species and cannot be conspecific: *Clitopilus albovelutinus* (G. Stev.) Noordel. & Co-David from New Zealand has whitish fruitbodies and a well developed lateral stipe (Horak 2008), and *C. lateralipes* (E. Horak) Noordel. & Co-David from Papua New Guinea shares the pale brown, striate pileus with *C. byssisedoides* but has a short, lateral stipe and ovoid to subglobose spores (Horak 1979). *Clitopilus balearicus* (Courtec. & Siquier) Noordel. & Co-David, the only previously reported European species with conchate basidiocarps, differs not only in having purely white pileus, but also by the presence of pseudocystidia which places it in another (*Rhodocybe*) section, *Crepidotoides* Singer ex T.J. Baroni (Courtecuisse & Siquier 1997).

Ongoing phylogenetic studies within the *Rhodocybe*–*Clitopilus* clade confirms that *C. byssisedoides* belongs to the subclade with a mixture of other species from sections *Rhodocybe*, *Decurrentes* and *Rufobrunnea*. The results of these studies will be published in due course.

Acknowledgements

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Literature cited

- Baroni TJ. 1981. A revision of the genus *Rhodocybe* Maire (*Agaricales*). Beih. Nova Hedwigia 67: 1–194.
- Baroni TJ, Horak E. 1994. *Entolomataceae* in North America III: New taxa, new combination and notes on species of *Rhodocybe*. Mycologia 86(1): 138–145.
- Co-David D, Langeveld D, Noordeloos ME. 2009. Molecular phylogeny and spore evolution of *Entolomataceae*. Persoonia 23: 147–176.
- Courtecuisse R, Siquier JL. 1997. *Rhodocybe balearica* nov.sp. Bolletino Gruppo Micologico G. Bresadola Nuova Serie 40: 181–186.
- Gminder A. 2005. Erstfunde von *Hydropus fluvialis*, *Lactocollybia cycadicola* und *Mycena neospeirea* in Deutschland, sowie weitere interessante Funde aus den Tropenhäusern des Botanischen Gartens von Jena (Thüringen). Boletus 28(1): 1–17.
- Horak E. 1979. Fungi agaricini novaezelandiae. VII. *Rhodocybe* Maire. New Zealand Journal of Botany 17: 275–281.
- Horak E. 2008. *Agaricales (Basidiomycota)* of New Zealand. 1. Pluteaceae, Entolomataceae. Fungi of New Zealand / Ngā Harore o Aotearoa, vol. 5. Hong Kong, Fungal Diversity Press.
- Moncalvo JM, Baroni TJ, Bhatt RP, Stephenson SL. 2004. *Rhodocybe paurii*, a new species from the Indian Himalaya. Mycologia 96(4): 859–865.
- Pegler DN. 1977. A revision of *Entolomataceae (Agaricales)* from India and Sri Lanka. Kew Bull. 32: 189–220.

New and noteworthy *Entoloma* species from the Primorsky Territory, Russian Far East

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Abstract — An account is given of some new and interesting *Entoloma* species collected in the Primorsky Territory of the Russian Far East. Six species (*Entoloma eugenei*, *E. kedrovense*, *E. pallidocarpum*, *E. angustispermum*, *E. pallidoflavum*, *E. subcaesiellum*) are new to science and their taxonomic position is discussed. In addition some interesting records of other species are documented.

Key words — *Entolomataceae*, new species, Kedrovaya Pad Nature Reserve

Introduction

Entoloma is the second largest genus of *Agaricales*. It is monophyletic (Co-David et al. 2009) and highly variable in morphological characters. It is estimated to contain more than 1500 species and is found worldwide, from arctic to tropical habitats (Largent 1977, 1994, Romagnesi & Gilles 1979, Horak 1980, 2008, Noordeloos 1981, 1992, 2004, Manimohan et al. 2006, Gates & Noordeloos 2007, Noordeloos & Hausknecht 2007, Noordeloos & Gates 2009). However, large areas are still under-explored, particularly in Africa, South America, India, and S.E. Asia.

The present paper gives an account of some new and interesting species collected by the second author in the Primorsky Territory, Russian Far East. Vassiljeva (1973), who provided the most complete data on *Entoloma* in this Territory, supplied descriptions and partly illustrated 34 species. Additional information can be found in the checklists of Nature Reserves of the Russian Far East and other papers (Azbukina & Kharkevich 1984, Egorova 2002, Vassiljeva & Bezdeleva 2006, Morozova 2007). The full list of literature devoted to the

mycobiota of this territory can be found in Bulakh (2005). In total, 52 species of *Entoloma* are known up to the present day for the Russian Far East.

The Kedrovaya Pad Nature Reserve is located at the southern tip of the Primorsky Territory in the spurs of the Eastern-Manchurian Mountains that extend eastward into Russia from China and North Korea. Its name originates from the Kedrovaya River, which flows through it. The reserve lies in the monsoon climate zone, and the warm, humid air masses from the Philippines combined with the mountainous relief play a significant role in creating a microclimate within the reserve. The vegetation of the Nature Reserve unites elements of the taiga and subtropical forests, but a southern flora predominates. Coniferous-broadleaved forests represent the native vegetation type, which today covers just over ten percent of the reserve's total area. Dominated by Manchurian firs (*Abies holophylla* Maxim.), these forests also incorporate warmth-loving trees such as *Quercus mongolica* Fisch. ex Turcz., *Tilia amurensis* Rupr., *T. mandshurica* Rupr. & Maxim., and *Fraxinus rhynchophylla* Hance. Forests of *Quercus mongolica* occupy nearly half of the territory and represent mostly secondary vegetation together with *Acer mono* Maxim., *Betula dahurica* Pall., *B. lutea* Michx., *Tilia amurensis*, *T. mandshurica*, and *Ulmus laciniata* Mayr. The valleys are occupied by *Alnus hirsuta* Turcz., *Chosenia arbutifolia* (Pall.) A.K. Skvortsov, *Fraxinus rhynchophylla*, *Populus maximowiczii* Henry, *Salix schwerinii* E.L. Wolf, *S. gracilistyla* Miq., *Ulmus laciniata*, and *U. japonica* (Sarg. ex Rehder.) Sarg. (Vasilyev et al. 1984). As can be expected from the geographic position of this area, the *Entoloma* flora appears to be Eurasian in character, with western and eastern elements.

Materials and methods

The specimens were collected, documented and preserved using standard methods. Macroscopic descriptions are based on the study of the fresh material as well as on analysis of the photos. The dried material was examined using standard microscopic techniques. Spores, basidia and cystidia were observed in squash preparations of small parts of the lamellae in 5% KOH or 1 % Congo Red in concentrated NH_4OH . The pileipellis was examined in a preparation of the radial section of the pileus in 5% KOH. Microscopic measurements and drawings were made with Micmed 2-2 and AxioImager A1 microscopes. Basidiospore dimensions are based on observing 20 spores, cystidia and basidia dimensions on observing at least 10 structures per collection. Spore length to width ratios are reported as Q. The collected material is deposited in the National Herbarium of the Netherlands (L) and in the Mycological Herbarium of the Komarov Botanical Institute (LE).



PLATE 1. 1. *Entoloma eugenei* (holotype). 2. *E. kedrovense* (holotype). 3. *E. pallidocarpum* (holotype). 4. *E. angustispermum* (holotype). 5. *E. subcaesiellum* (holotype). 6. *E. roseoflavum* (holotype). 7. *E. caesiellum* (LE 253780). 8. *E. parasericellum* (LE 253788). 9. *E. gomerense* (LE 253784).

Taxonomy

I. New taxa

1. *Entoloma eugenei* Noordel. & O.V. Morozova, sp. nov.

FIG. 1, PLATE 1.1.

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PILEUS 13–45 mm latus, semiglobosus demum convexus, plano-convexus, margine involuto, haud hygrophanus, haud translucente striatus, toto velutinus, juventute cyaneus demum margine violaceo. *LAMELLAE* adnato-emarginatae, albae demum rosae acie concolor. *STIPES* 30–80 × 4–8 mm, clavatus vel cylindraceus basi incrassata, squamuliscum, pileo concolor, apice violaceo, basi albotomentosa. *CARO* albida. *ODOR* paulum acer. *SAPOR* nullus. *SPORAE* 10.0–12.5 × 6.0–8.0 µm, Q = 1.3–1.7, 5–7 angulatae. *BASIDIA* 34–44 × 9–12 µm tetrasporigera fibulata. *ACIES* lamellarum sterilis. *CHEILOCYSTIDIA* 28.5–37.5 × 6.5–15.5 µm, cylindracea vel leviter lageniformia. *PILEIPELLIS* trichoderma elementis terminalibus 90–200 × 12–20 µm pigmento caeruleo intracellulari. *FIBULAE* abundantes. *GRANULA* LUCENTIA desunt. *HABITAT* ad terram in silva frondosa humida.

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, the right bank of the Kedrovaya River, 43°05'51" N, 131°33'34" E, 24 Aug. 2005, leg. E. Popov, LE 253771.

ETYMOLOGY: this species is named in honor of Dr Eugene Popov for his support.

MACROCHARACTERS — *PILEUS* 13–45 mm broad, hemispherical expanding to plano-convex with incurved margin, not hygrophanous, not translucently striate, entirely velvety when young, becoming glabrous at the margin, uniformly deep blue (Indian blue) at first, then with violet tinge at margin, dry. *LAMELLAE* adnate-emarginate with decurrent tooth, pure white in youth becoming pink, with irregular concolorous edge. *STIPE* 30–80 × 4–8 mm, clavate or cylindrical with swollen base (to 15 mm), concolourous with the pileus or slightly paler, entirely squamulose with concolorous squamules, base with white tomentum. *FLESH* white, dark blue beneath the surface. *SMELL* slightly spicy. *TASTE* mild.

MICROCHARACTERS — *SPORES* 10.0–12.5 × 6.0–8.0 µm, Q = 1.3–1.7, heterodiametrical, with 5–7 angles in side view. *BASIDIA* 34–44 × 9–12 µm, clavate, clamped. *LAMELLAE* edge sterile. *CHEILOCYSTIDIA* 28.5–37.5 × 6.5–15.5 µm, cylindrical, narrowly lageniform or irregularly shaped, colourless. *HYMENOPHORAL TRAMA* regular, made up of cylindrical to inflated elements, 10–20 µm wide. Brilliant granules absent. *PILEIPELLIS* a trichoderm of cylindrical hyphae with terminal elements 90–200 × 12–20 µm. Pigment blue, intracellular. *CLAMP CONNECTIONS* abundant in pileipellis.

HABITAT — On soil in the flood plain forest.

COMMENTS — *Entoloma eugenei* is a striking blue species in section *Leptonia*, characterized by the trichodermal pileipellis with clamp connections. It is close to the European *E. dichroum* (Pers.) P. Kumm. and *E. tjallingiorum* Noordel. and the North American *E. cyaneum* (Peck) Sacc., from which it differs in

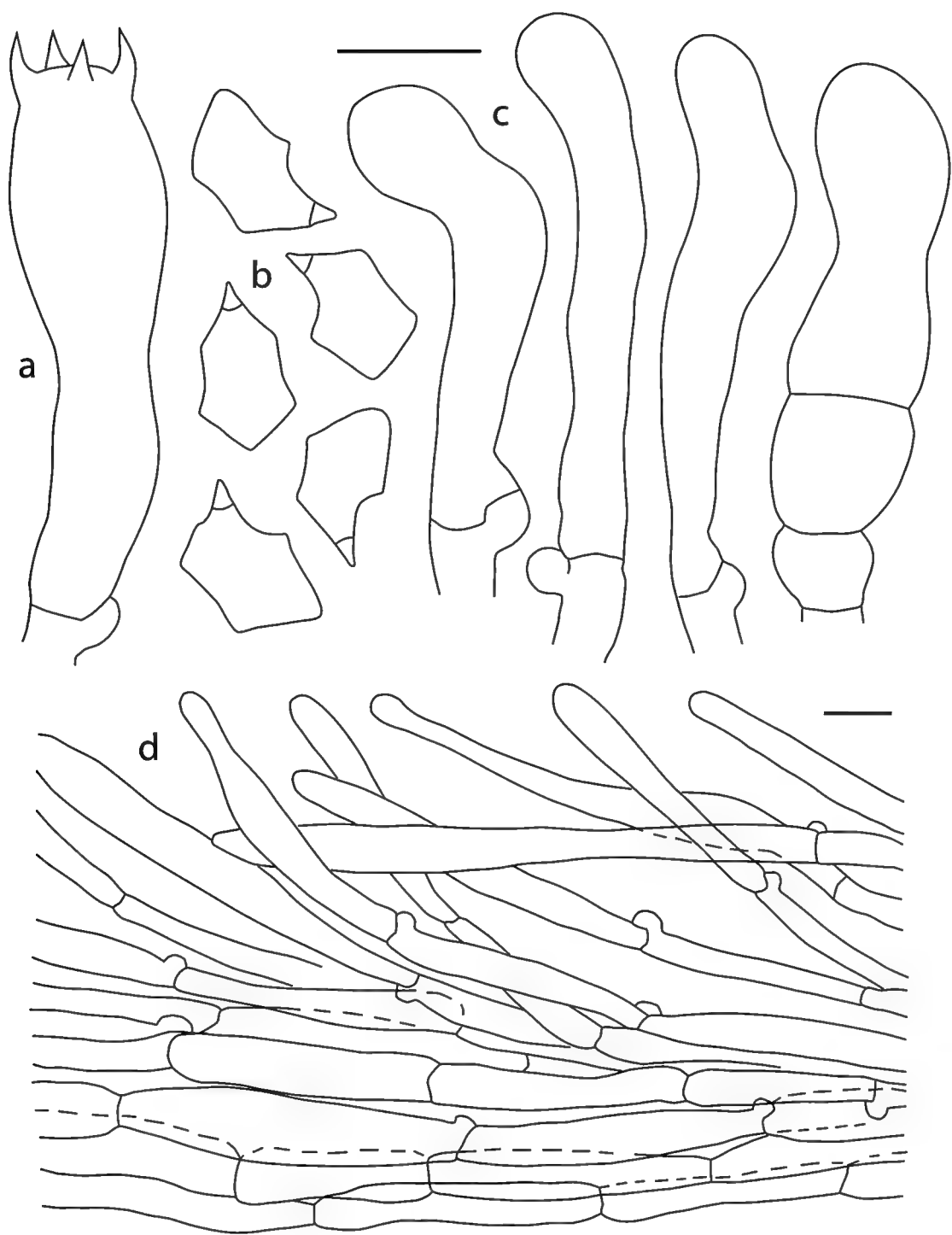


FIG. 1. *Entoloma eugenei*. Basidium (a), spores (b), cheilocystidia (c), and pileipellis (d).
All figs from holotype. Bar = 10 μ m.

the deep blue colour, strongly contrasting white lamellae, and shape of the spores and cheilocystidia. *Entoloma egregium* E. Horak from New Guinea is macroscopically similar but differs with respect to spore shape, cheilocystidia and pileipellis structure. *Entoloma panniculus* (Berk.) Sacc. from Australia is similarly colored but produces smaller spores and different pileipellis pigments (Berkeley 1859).

2. *Entoloma kedrovense* Noordel. & O.V. Morozova, sp. nov.

FIG. 2, PLATE 1.2

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PILEUS 15–30 mm *latus*, *conicus vel semiglobosus demum convexus, plano-convexus, haud hygrophanus, paulisper translucens striatus, obscure griseobrunneus, juventute tomentosus, demum centro squamuloso, margine fibrilloso-rimoso. LAMELLAE* *adnato-emarginatae, paulo dente decurrentes, albae demum rosae acie concolor. STIPES* 70–90 × 2.5–4 mm, *cylindraceus vel compressus, griseo-caeruleus, longitudinaliter fibrillosus, apice squamuliscum, basi albotomentosa. CARO* *superficie concolor odore saporeque indistinctis. SPORAE* 8.0–11.2 × 6.0–7.5 µm, *Q* = 1.3–1.6, 5–6 *angulatae. BASIDIA* 21.5–37.0 × 12–13.5 µm *tetrasporigera efibulata. ACIES lamellarum heterogenea, cheilocystidia* 18–27 × 5–9 µm, *cylindracea, clavata vel formae irregularis. PILEIPELLIS cutis trichoderma transient, centro trichoderma vel hymeniderma elementis terminalibus inflatis* 25–80 × 7–19 µm *pigmento griseobrunneo intracellulari; fibulae desunt. GRANULA LUCENTIA abundantia. HABITAT ad terram in silva frondosa humida.*

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, the right bank of the Kedrovaya River, 43°05'56" N, 131°33'21" E, 17 Aug. 2005, *leg. O. Morozova, LE 253772.*

ETYMOLOGY: named after the type locality — valley of the Kedrovaya River.

MACROCHARACTERS — **PILEUS** 15–30 mm broad, conical to hemispherical, then convex to plano-convex, with minute pointed umbo, never distinctly umbilicate, not hygrophane, slightly translucently striate at margin only, dark grey-brown, tomentose when young, breaking up into rather coarse squamules at centre, with smaller, rather regularly distributed squamules towards margin, on paler brown background, sometimes with a slight purple tinge. **LAMELLAE** adnate-emarginate with small decurrent tooth, whitish then pink with concolourous edge. **STIPE** 70–90 × 2.5–4 mm, cylindrical or compressed with longitudinal groove, mouse gray or, sometimes with purplish tinge, minutely squamulose in the upper half grayish blue, longitudinally fibrillose in the lower part, base with white tomentum. **CONTEXT** concolourous with the surface, whitish in the inner part. **ODOUR** indistinct. **TASTE** indistinct.

MICROCHARACTERS — **SPORES** 8.0–11.2 × 6.0–7.5 µm, *Q*=1.3–1.6, heterodiametrical, with 5–6 angles in side view. **BASIDIA** 21.5–37.0 × 12–13.5 µm, clavate, clamps not seen. **LAMELLAE** edge heterogeneous. **CHEILOCYSTIDIA** 18–27 × 5–9 µm, cylindrical to clavate or irregularly shaped, septate, colourless. Brilliant granules abundant in hymenophoral- and pilei-trama. **PILEIPELLIS** cutis with transition to a trichoderm, in central part more like a trichoderm or hymeniderm of inflated terminal elements, 25–80 × 7–19 µm. Pigment dark grey-brown, intracellular. **CLAMP CONNECTIONS** absent.

HABITAT — On soil in the flood plain forest.

COMMENTS — *Entoloma kedrovense* is distinguished by the dark grey squamulose pileus and floccose, blue-grey stipe. It keys out in series *Anatinum* of section *Cyanula* (Noordeloos 1992). *Entoloma coeruleoflocculosum* Noordel. has a deep

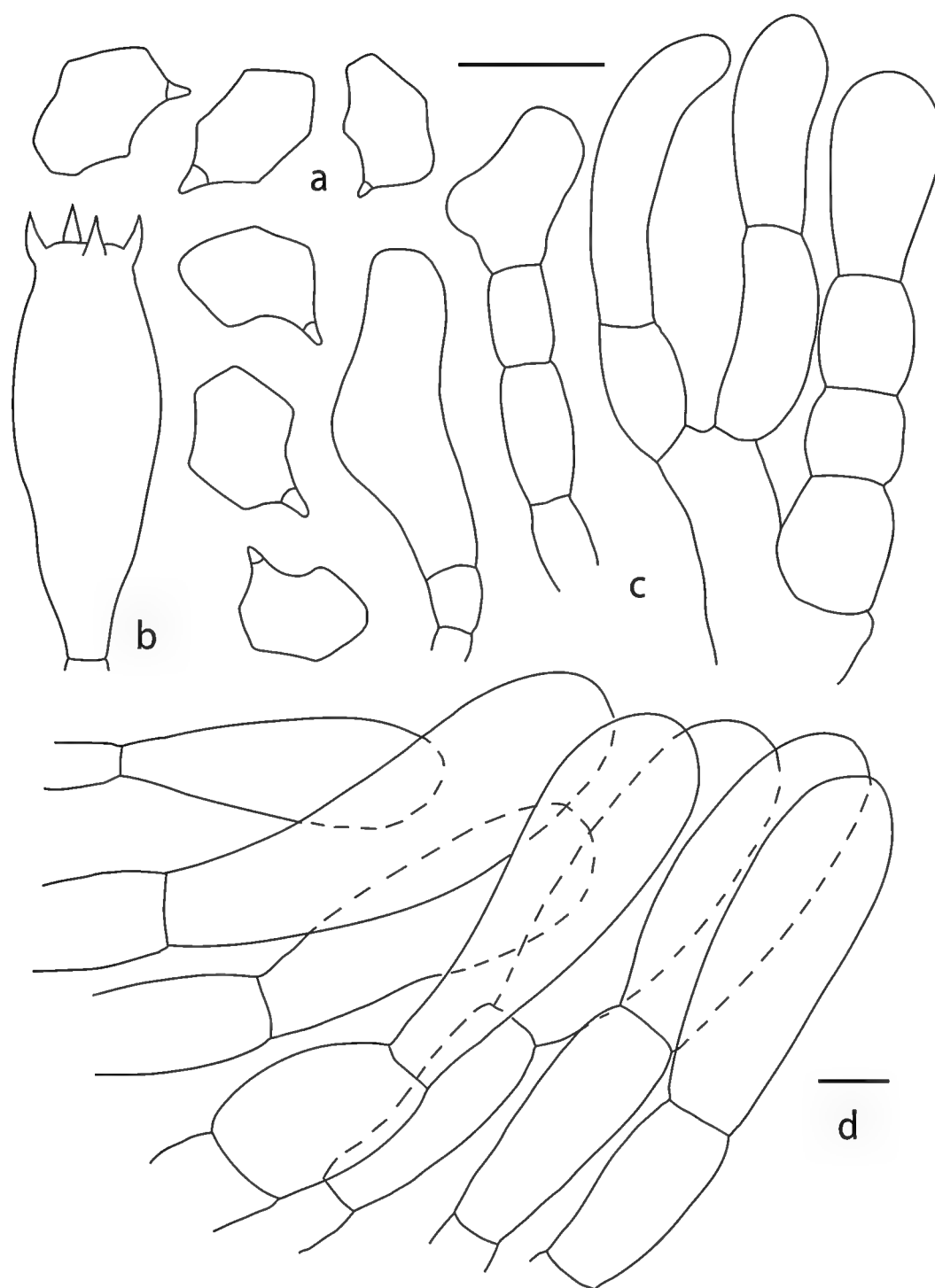


FIG. 2. *Entoloma kedrovense*. Spores (a), basidium (b), cheilocystidia (c), and pileipellis (d).
All figs from holotype. Bar = 10 μ m.

reddish brown pileus and a completely sterile lamella edge, often with brown intracellular pigment. *Entoloma mougeotii* (Fr.) Hesler has a more violaceous-grey pileus and stipe, a more regularly tomentose-squamulose pileus, and a completely sterile lamella edge. In Largent (1977) this species keys out in series *Paludocybe*, close to *Leptonia gracilipes* Peck, which, however, differs among other things by having a polished, glabrous stipe. None of the Asian species in Horak (1980) fits with our species.

3. *Entoloma pallidocarpum* Noordel. & O.V. Morozova, sp. nov. FIG. 3, PLATE 1.3

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PILEUS 80–130 mm *latus*, *plano-convexus*, *centro applanato margine recto*, *hygrophanus*, *paulisper translucente striatus*, *pallide brunneolus*, *in sicco striis radialibus pallescens*, *glaber*, *radiatim rugulosus*. *LAMELLAE confertae*, *adnato-emarginatae*, *ad 10 mm late*, *albae demum rosae acie denticulata concolor*. *STIPES* 140–160 × 17–20 mm, *cylindraceus*, *firmus*, *albus*, *innate longitudinaliter fibrillosus basi albotomentosa*. *CARO albo odore saporeque leviter farinaceis demum nucis*. *SPORAE* 7.0–9.2 × 6.0–7.5 µm, *Q* = 1.0–1.3, 6–7 *angulatae*. *BASIDIA* 37–54 × 9–14 µm, *tetrasporigera fibulata*. *ACIES lamellarum heterogenea*. *CHEILOCYSTIDIA* 15–50 × 3–10 µm, *cylindracea vel formae irregularis*. *PILEIPELLIS cutis e hyphis 2–4 µm latis pigmento intracellulari vel incrustato formata; fibulae abundantes*. *HABITAT ad terram in silva frondosa*.

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, vicinities of the Second Zolotoy stream, 43°06'37" N, 131°31'31" E, 20 Aug. 2005, *leg. O. Morozova*, LE 253773.

ETYMOLOGY: *pallidus* = pale, *carpum* = fruit (body), referring to the pale basidiomes.

MACROCHARACTERS — *PILEUS* 80–130 mm broad, plano-convex with applanate centre and straight margin, hygrophanous, slightly translucently striate at margin, pale brownish, pallescent on drying in radial streaks, glabrous, radially rugulose. *LAMELLAE* crowded, adnate-emarginate, to 10 mm broad, white then pinkish with irregular concolorous edge. *STIPE* 140–160 × 17–20 mm, cylindrical, white, innately longitudinally fibrillose, glabrous, base with white tomentum. *FLESH* white. *ODOUR* farinaceous then reminiscent of hazel nuts. *TASTE* mild.

MICROCHARACTERS — *SPORES* 7.0–9.2 × 6.0–7.5 µm, *Q* = 1.0–1.3, subisodiametrical, with 6–7 angles in side view. *BASIDIA* 37–54 × 9–14 µm, narrowly clavate, clamped. *LAMELLAE* edge heterogeneous. *CHEILOCYSTIDIA* 15–50 × 3–10 µm, cylindrical or irregularly shaped, colourless. *PILEIPELLIS* a cutis of 2–4 µm wide, cylindrical sometimes slightly ascending hyphae. Pigment intracellular, in some hyphae of subpellis slightly incrusting. *HYMENOPHORAL-AND PILEI-TRAMA* regular, made up of short, inflated elements, 40–120 × 5–10 µm. *CLAMPS* numerous in the pileipellis.

HABITAT — On soil in broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp., *Alnus* spp.).

COMMENTS — Within the group of tricholomatoid species of subgenus *Rhodopolia*, only a few species have well-developed cheilocystidia. *Entoloma noordeloosii* Hauskn., known from Central Europe, has larger spores and lacks incrusting pigment. *Entoloma inusitatum* Noordel. et al., another widespread European species, differs by smaller basidiomes with sordid brown colour, larger spores, and more intensely incrusting hyphae in the uppermost layer of the pileus. *Entoloma kallioi* Noordel. is a much darker species with filiform

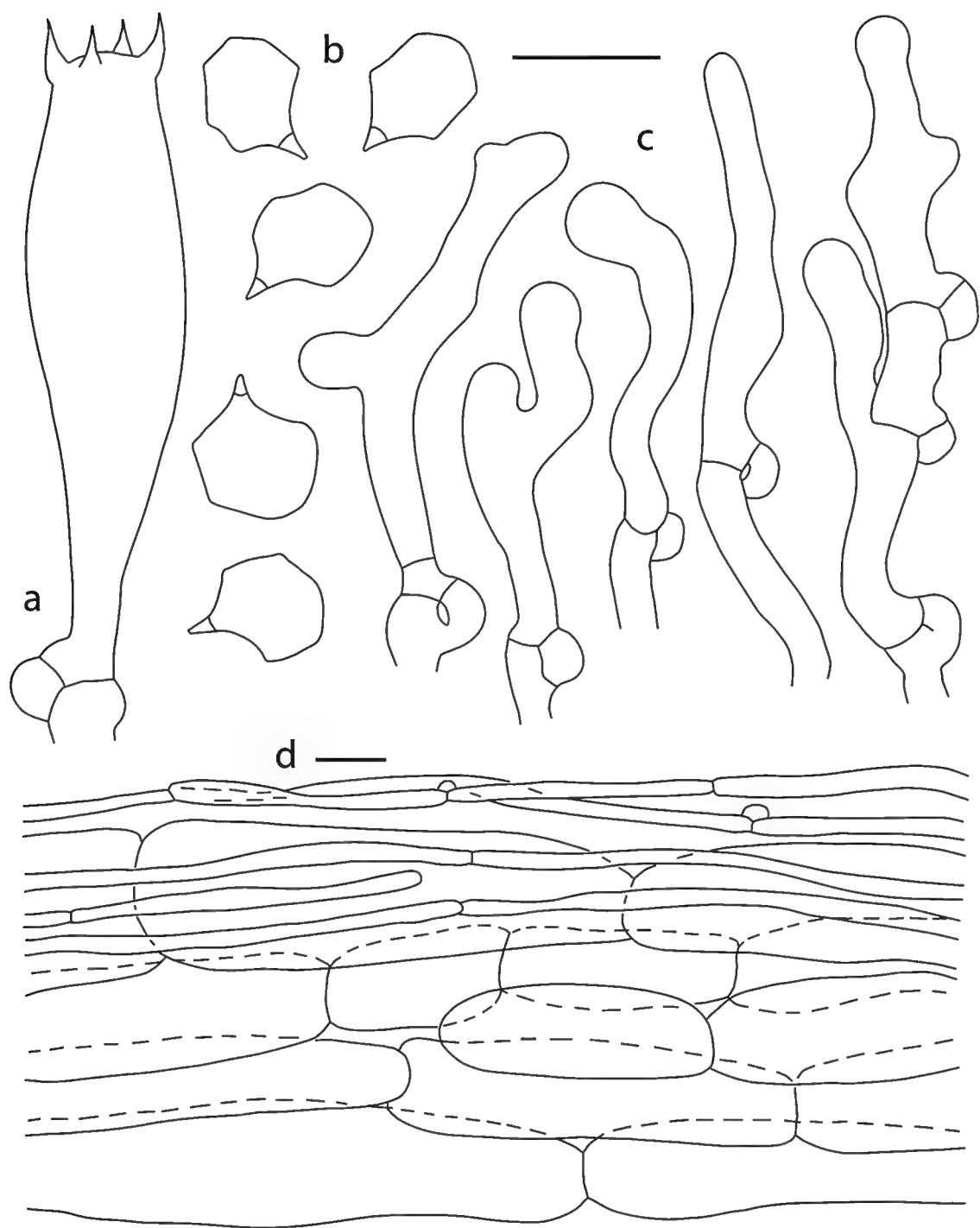


FIG. 3. *Entoloma pallidocarpum*. Basidium (a), spores (b), cheilocystidia (c), and pileipellis (d). All figs from holotype. Bar = 10 μ m.

cheilocystidia (Noordeloos 2004). No similar species could be found in Horak (1980).

4. *Entoloma angustispermum* Noordel. & O.V. Morozova, sp. nov.

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FIG. 4, PLATE 1.4

PILEUS 15–20 mm latus, semiglobosus demum plano-convexus centro depresso, paulo hygrophanus, paulisper translucente striatus, alutaceus, pallide brunneolus, margine pallidior centro obscurior minute squamuloso. *LAMELLAE* adnato-emarginatae, albae

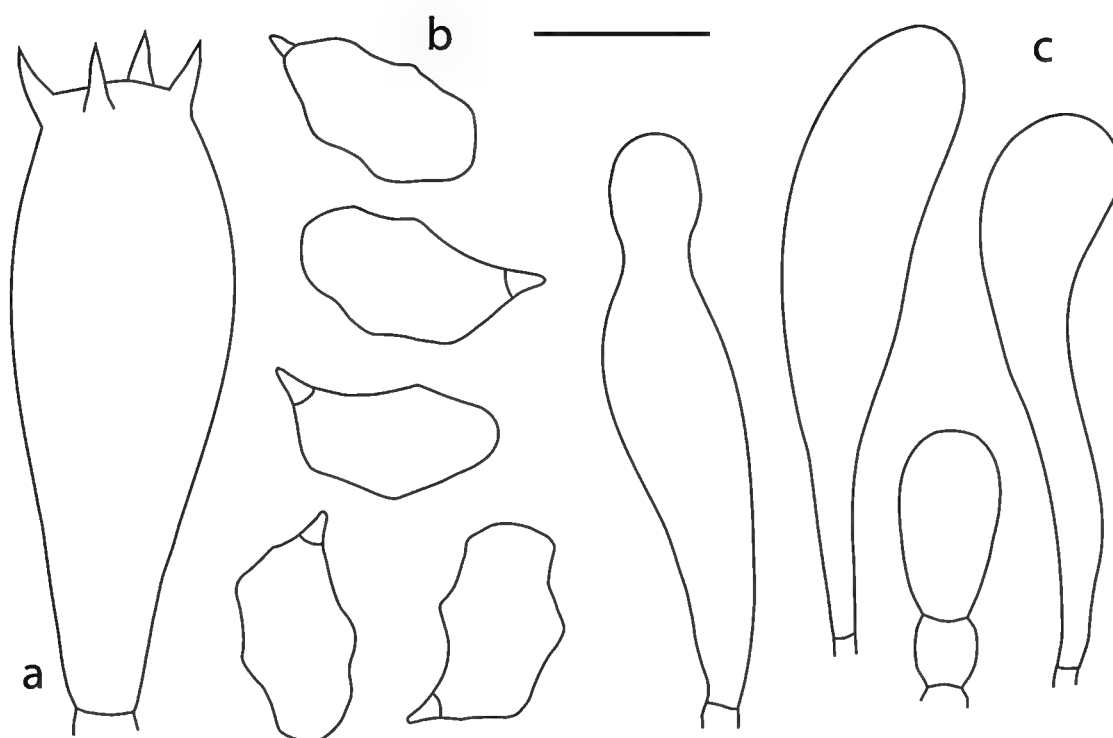


FIG. 4. *Entoloma angustispermum*. Basidium (a), spores (b), and cheilocystidia (c).

All figs from holotype. Bar = 10 μ m.

demum rosae acie concolor. STIPES 60–80 \times 2.5 mm, cylindraceus vel compressus, griseolus, politus, basi albotomentosa. CARO superficie concolor odore saporeque indistinctis. SPORAE 9.0–13.0 \times 5.5–7.6 μ m, Q=1.3–1.8(2.1), 6–8 angulatae. BASIDIA 21–32 \times 11.8–13.5 μ m tetrasporigera efbulata. ACIES lamellarum heterogenea. CHEILOCYSTIDIA 12–40 \times 7–15 μ m, cylindracea vel clavata interdum septata. PILEIPELLIS cutis trichoderma transient, elementis terminalibus cylindraceis vel clavatis 30–70 \times 9–19 μ m pigmento intracellulari; fibulae desunt. GRANULA LUCENTIA adsunt. HABITAT ad terram in silva frondosa.

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, vicinities of the Second Zolotoy stream, 43°06'37" N, 131°31'31" E, 20 Aug. 2005, leg. O. Morozova, LE 253774.

ETYMOLOGY: *angustus* = narrow, referring to the narrow spores.

MACROCHARACTERS — PILEUS 15–20 mm broad, hemispherical when young, expanding to plano-convex with depressed centre, slightly hygrophanous, translucently striate to half of radius, smooth, pale beige, with darker, minutely squamulose centre. LAMELLAE adnate-emarginate, first white then pink with concolorous edge. STIPE 60–80 \times 2.5 mm, cylindrical or compressed with longitudinal groove, greyish beige, polished, glabrous, base with white tomentum. CONTEXT whitish. ODOUR indistinct. TASTE indistinct.

MICROCHARACTERS — SPORES 9.0–13.0 \times 5.5–7.6 μ m, Q=1.3–1.8(2.1), heterodiametrical, with 6–8 angles in side view. BASIDIA 21–32 \times 11.8–13.5 μ m, clavate, no clamps seen. LAMELLAE edge heterogeneous. CHEILOCYSTIDIA 15–30

× 6–7 µm, cylindrical or clavate, sometimes septate, colourless. PILEIPELLIS a cutis with transition to a trichoderm, made up of cylindrical to clavate elements, 30–70 × 9–19 µm. Brilliant granules present in trama. Pigment intracellular in pileipellis. CLAMP CONNECTIONS absent.

HABITAT — On soil in the broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp., *Alnus* spp.).

COMMENTS — *Entoloma angustispermum* keys out in section *Cyanula* stirps *Sarcitulum* based on the pale brown colour, translucently striate pileus, and polished stipe (Noordeloos 2004). No European species has such narrow spores. *Entoloma mutabilipes* Noordel. & Liiv from Europe also is similar, but usually has a distinctly blue stipe, particularly when young, and smaller spores (Noordeloos & Liiv 1992). No similar species could be found in Horak (1980).

5. *Entoloma roseoflavum* Noordel. & O.V. Morozova, sp. nov. FIG. 5, PLATE 1.6
MYCOBANK 515678

PILEUS 13–45 mm latus, semiglobosus demum plano-convexus vel applanatus centro depresso, paulo hygrophanus, translucente striatus, alutaceus, pallide brunneolus ad albido adumbratione roseolus margine pallidior glabro centro flavobrunneo squamuloso. LAMELLAE adnato-emarginatae, albae demum rosae acie concolor. Stipes 50–100 × 2–3 mm, cylindraceus vel compressus, albus demum flavidus, politus, basi albotomentosa. CARO alba odore saporeque indistinctis. SPORAE 8.3–11.0 × 6.5–7.8 µm, Q=1.2–1.5, 5–7 angulatae. BASIDIA 29–32 × 9–12 tetrasporigera efibulata. ACIES lamellarum sterilis. CHEILOCYSTIDIA 39–81 × 5–12 µm, cylindracea vel clavata, septata. PILEIPELLIS cutis trichoderma transient, elementis terminalibus clavatis 10–22 µm latus pigmento intracellularem; fibulae desunt. GRANULA LUCENTIA adsunt. HABITAT ad terram in silva frondosa humida.

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, the right bank of the Kedrovaya River, 43°05'56" N, 131°33'21" E, 17 Aug. 2005, leg. O. Morozova, LE 253775.

ETYMOLOGY: *roseus* = pink, *flavum* = yellow, referring to the colour of the basidiomes.

MACROCHARACTERS — PILEUS 13–45 mm broad, hemispherical when young, expanding to plano-convex then applanate with depressed centre, slightly hygrophamous, translucently striate to half of the radius, squamulose at centre, glabrous towards margin, pale beige, buff with a pink hue, with contrasting dark yellowish brown centre. LAMELLAE adnate-emarginate with decurrent tooth, first white then pink with irregular concolorous edge. STIPE 50–100 × 2–3 mm, cylindrical or compressed with longitudinal groove, white then yellowish, polished, glabrous, base with white tomentum. CONTEXT white. ODOUR indistinct. TASTE indistinct.

MICROCHARACTERS — SPORES 8.3–11.0 × 6.5–7.8 µm, Q=1.2–1.5, heterodiametrical, with 5–7 angles in side view. BASIDIA 29–32 × 9–12 µm, clavate, clampless. LAMELLAE edge sterile. CHEILOCYSTIDIA 39–81 × 5–12 µm,

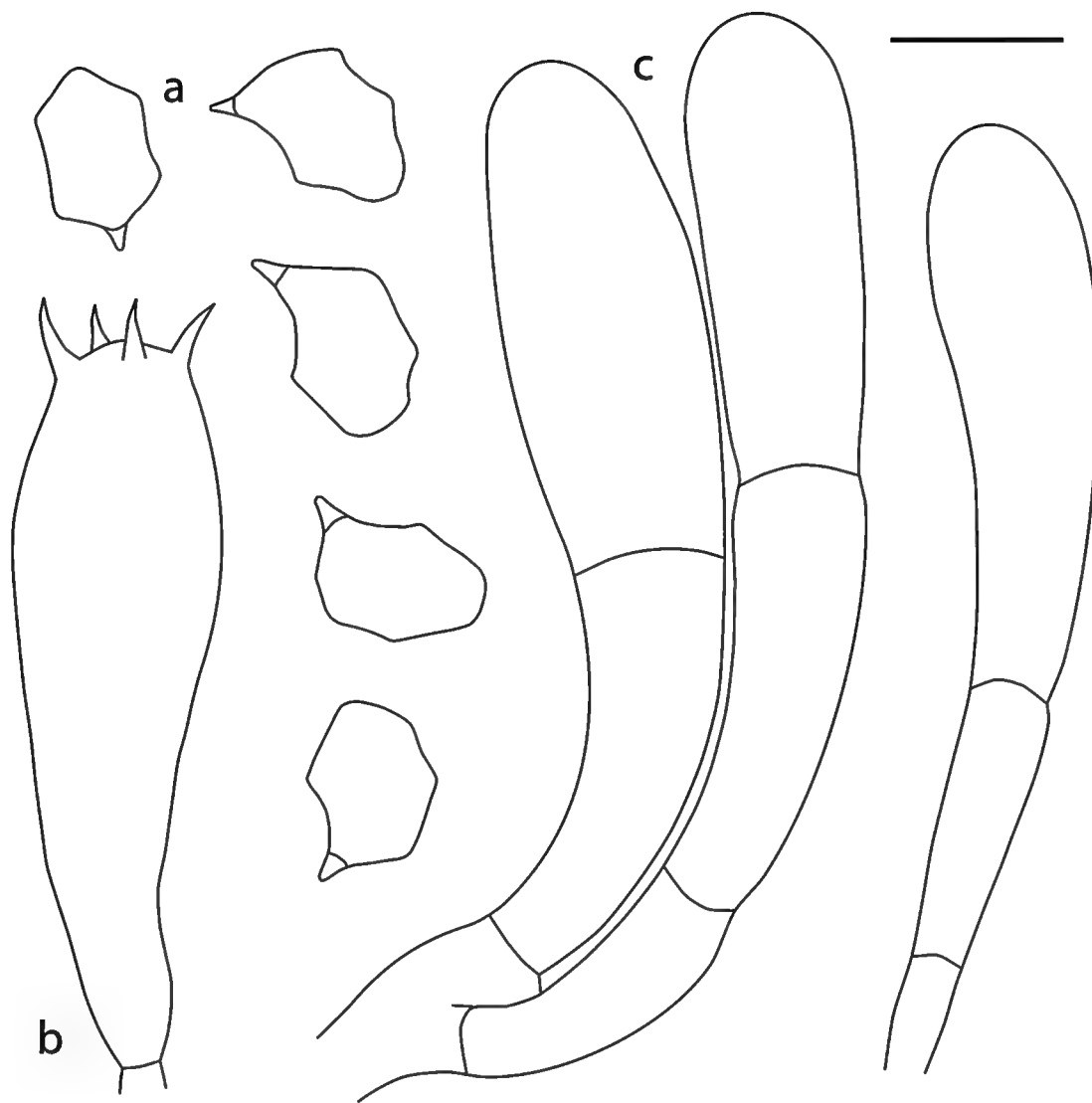


FIG. 5. *Entoloma roseoflavum*. Spores (a), basidium (b), and cheilocystidia (c).
All figs from holotype. Bar = 10 μ m.

cylindrical or clavate, septate, colourless. PILEIPELLIS a cutis with transition to a trichoderm made up of clavate terminal elements, 10–22 μ m wide. Pigment intracellular. Brilliant granules present. CLAMP CONNECTIONS absent.

HABITAT — On soil in the flood plain forest.

COMMENTS — *Entoloma roseoflavum* is a pale member of section *Cyanula*, characterized mainly by the pale pinkish pileus with yellow centre and yellowish stipe. It is distinguished from the European species with pink tinges as follows: *Entoloma ritae* Noordel. & Wölfel has also a pinkish pileus and yellow stipe but clearly differs microscopically by the larger spores, presence of clamp-connections, and pileipellis structure (Wölfel & Noordeloos 1997); *E. roseotinctum* Noordel. & Liiv has grey tinges in pileus and stipe and lageniform cheilocystidia (Noordeloos & Liiv 1992); *E. roseum* (Longyear) Hesler and

E. reinwaldii Noordel. & Hauskn. differ by having more intensely pink basidiomes without yellow tinges (Hesler 1967, Noordeloos & Hausknecht 2000). *E. roseoluteolum* G.M. Gates & Noordel. from Tasmania is superficially similar but differs by the slight violaceous tinges in the pileus and the fertile lamella edge without cheilocystidia (Gates & Noordeloos 2007).

6. *Entoloma subcaesiellum* Noordel. & O.V. Morozova, sp. nov.

MYCOBANK 515679

FIG. 6, PLATE 1.5

PILEUS 5–20 mm *latus*, *conicus vel semiglobosus demum plano-convexus*, *paulo hygrophanus*, *translucentestriatus*, *caeruleus*, *demum margine pallide violaceo*, *centro squamuliscum*. *LAMELLAE* *adnato-emarginatae*, *albae demum rosae acie concolor*. *STIPES* 45–70 × 2–3 mm, *cylindraceus vel compressus*, *caeruleus*, *politus*, *basi albotomentosa*. *CARO superficie concolor odore saporeque indistinctis*. *SPORAE* 8.0–11(–12.0) × 6.0–8.0 μm, *Q* = 1.2–1.5, 5–7 *angulatae*. *BASIDIA* 21–34 × 8–11.5 μm, *bi- vel tetrasporigera efibulata*. *ACIES lamellarum sterilis vel heterogenea*. *CHEILOCYSTIDIA* 12–40 × 7–15 μm, *clavata vel lageniformia*. *PILEIPELLIS cutis trichoderma transient*, *elementis terminalibus clavatis* 30–90 × 7–21 μm *pigmento caeruleo intracellulari*; *fibulae desunt*. *GRANULA LUCENTIA adsunt*. *HABITAT ad terram in silva frondosa humida*.

HOLOTYPE: RUSSIA; Primorsky Territory, Kedrovaya Pad Nature Reserve, the right bank of the Kedrovaya River, 43°05'56" N, 131°33'21" E, 17 Aug. 2005, *leg. O. Morozova*, LE 253776.

ETYMOLOGY: named after its similarity to *Entoloma caesiellum*.

MACROCHARACTERS — *PILEUS* 5–20 mm broad, conical to hemispherical, expanding to plano-convex, with or without small umbo, or slightly depressed centre, faintly hygrophanous, translucently striate up to the centre, bright blue with fine darker blue squamules at centre, glabrous towards margin, fading to light purplish gray at margin on drying. *LAMELLAE* adnate-emarginate, almost free, first white then pink with concolorous, straight edge. *STIPE* 45–70 × 2–3 mm, cylindrical or compressed with longitudinal groove, blue, concolorous with pileus, smooth, glabrous, polished, matt at base with white tomentum. **ODOUR** indistinct. **TASTE** indistinct.

MICROCHARACTERS — *SPORES* 8.0–11(–12.0) × 6.0–8.0 μm, *Q* = 1.2–1.5, heterodiametrical, with 5–7 angles in side view. *BASIDIA* 21–34 × 8–11.5 μm, clavate, 2–4 spored, clampless. *LAMELLAE* edge sterile or heterogeneous. *CHEILOCYSTIDIA* 12–40 × 7–15 μm, mostly shorter than the basidia, broadly clavate or lageniform, colourless. *PILEIPELLIS* a cutis with transitions to a trichoderm, particularly at centre of pileus, made up of cylindrical to clavate elements, 30–90 × 7–21 μm. Pigment intracellular. Brilliant granules present in hymenophoral- and pilei-trama. **CLAMPS** absent.

HABITAT — On soil in the flood plain forest and broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp., *Alnus* spp.).

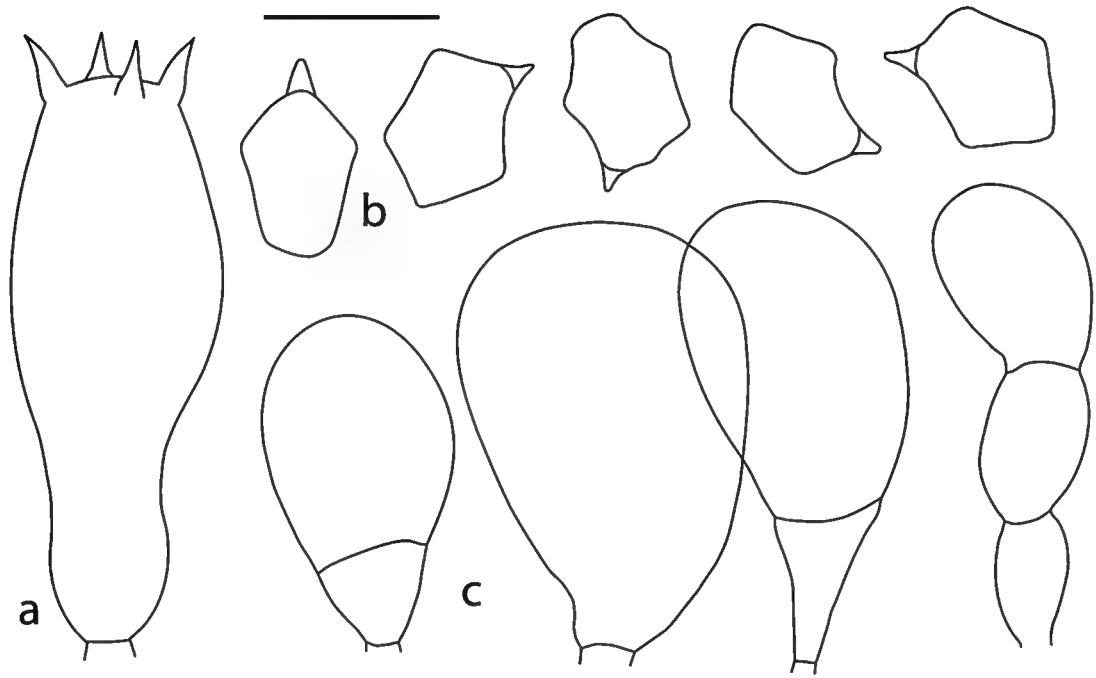


FIG. 6. *Entoloma subcaesiellum*. Basidium (a), spores (b), and cheilocystidia (c).
All figs from holotype. Bar = 10 μ m.

ADDITIONAL COLLECTIONS EXAMINED — **RUSSIA. PRIMORSKY TERRITORY, Kedrovaya Pad Nature Reserve**, VICINITIES OF THE SECOND ZOLOTY STREAM, 43°06'37" N, 131°31'31" E, 20 Aug. 2005, leg. O. Morozova, LE 253777; **Kedrovaya Pad Nature Reserve**, THE RIGHT BANK OF THE KEDROVAYA RIVER, 43°05'56" N, 131°33'21" E, 17 Aug. 2005, leg. O. Morozova, LE 253779.

COMMENTS — *Entoloma caesiellum* differs by having slenderer and longer cheilocystidia, and a more slate blue-grey, convex-umbilicate pileus. This species also strongly resembles *E. chalybeum* var. *lazulinum* (Fr.) Noordel., differing however by the lack of blue tinges in the lamellae, and the concolorous lamella edge with relatively short and broad cheilocystidia which do not arise from a strand of hyphae running along the lamella edge (*serrulatum*-type, see Noordeloos 2004).

II. New records

7. *Entoloma caesiellum* Noordel. & Wölfel, in Noordeloos et al., Z. Mykol.

61(2): 185 (1995)

FIG. 7, PLATE 1.7

MACROCHARACTERS — PILEUS 30–40 mm broad, hemispherical when young, expanding to plano-convex with depressed centre, slightly hygrophalous, translucently striate to half of the radius, centrally squamulose, smooth towards margin, light beige, with delicate blue tinge on the margin. LAMELLAE adnate-emarginate, first white then pink with irregular concolorous edge. STIPE

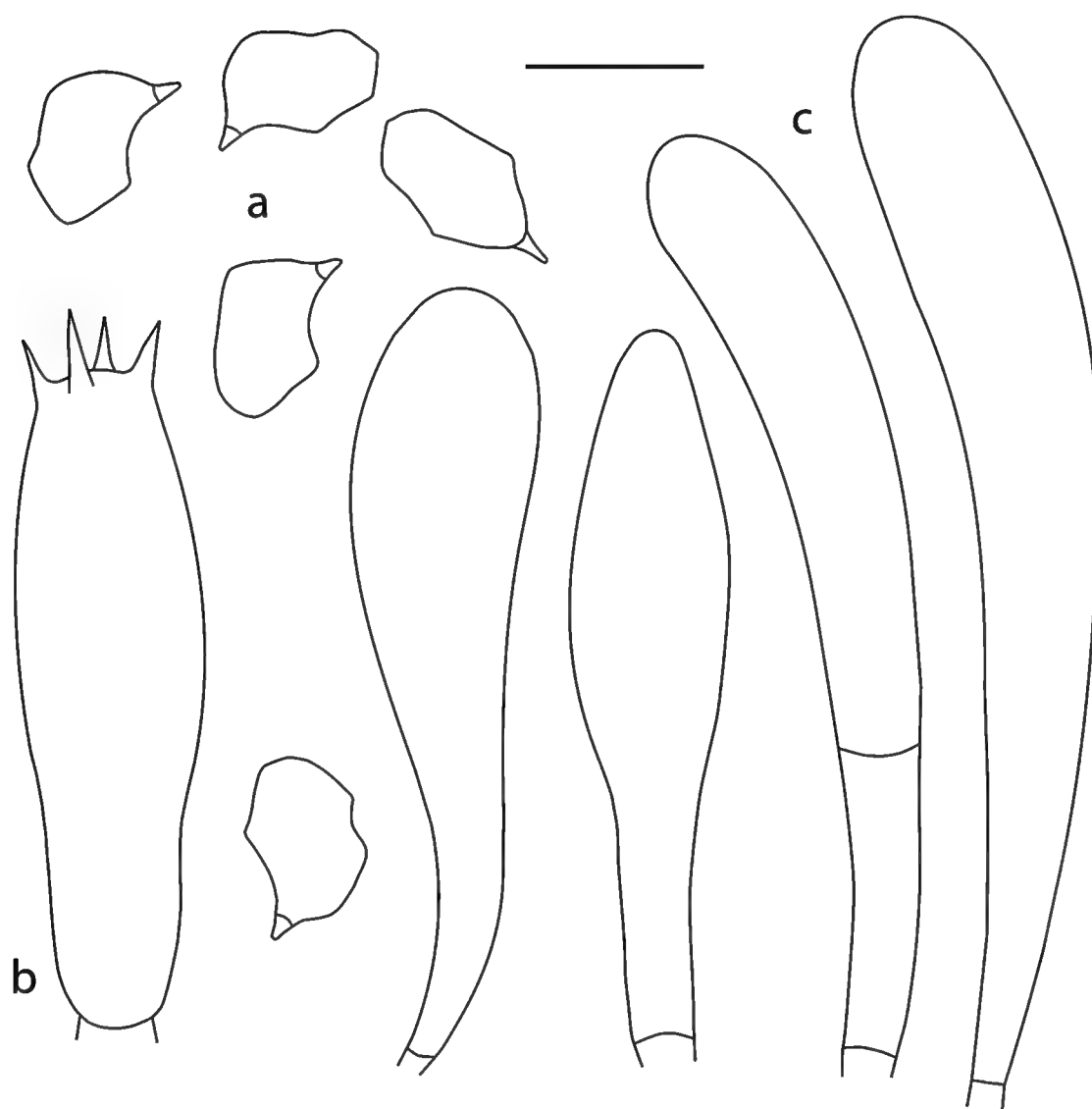


FIG. 7. *Entoloma caesiellum*. Spores (a), basidium (b), and cheilocystidia (c).
From LE 253780. Bar = 10 μ m.

70–80 \times 2–3 mm, cylindrical or compressed with longitudinal groove, sky blue, polished, glabrous, base with white tomentum. ODOUR slightly spicy. TASTE indistinct.

MICROCHARACTERS — SPORES 8.5–10.4 \times 5.7–7.8 μ m, $Q = 1.3$ –1.6, heterodiametrical, with 5–7 angles in side view. BASIDIA 31.2–43.5 \times 9.0–10.5 μ m, clampless. LAMELLAE edge sterile. CHEILOCYSTIDIA 28.6–72.8 \times 7.8–16.9 μ m, narrowly clavate to lageniform, colourless. PILEIPELLIS a cutis with transition to a trichoderm. Pigment intracellular. CLAMPS absent.

HABITAT — on soil in *Alnus hirsuta* and *Quercus mongolica* forest.

COLLECTION EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, THE LEFT BANK OF THE KEDROVAYA RIVER, SOUTHERN SLOPE OF THE GAKKELEVSKY MOUNTAIN RIDGE, 43°06'10" N, 131°33'34" E, 19 Aug. 2005, leg. O. Morozova, LE 253780.

COMMENTS — *Entoloma caesiellum* is characterized by the conical to convex with umbilicate centre, translucently striate, brownish beige pileus with minute blackish blue squamules in the central part and pale blue-lilac tinge in the marginal zone, white then pink lamellae with concolorous edge, and blue-grey, polished stipe, small spores, and relatively slender cheilocystidia. So far this species had been known only from the type locality in Italy where it was found in a subalpine peat-bog with *Betula* and *Alnus* (Noordeloos 2004), and in a submontane forest in Spain (Vila & Caballero 2007). *Entoloma pseudocoelestinum* Arnolds is similar but has a brown-tinged pileus and lacks cheilocystidia. *Entoloma chalybeum* var. *lazulinum* differs by the bluish lamellae with brown edge and larger spores (Noordeloos 1992). *Entoloma decolorans* E. Horak from New Zealand has a darker, entirely squamulose, non-translucent striate pileus (Horak 1973). *Entoloma transmutans* G.M. Gates & Noordel. from Tasmania differs by having pinkish purple tinges in the expanding pileus, and much smaller spores (Gates & Noordeloos 2007).

8. *Entoloma parasericellum* Corner & E. Horak, in Horak, Beih. Nova

Hedwigia 65: 97 (1980)

FIG. 8, PLATE 1.8

MACROCHARACTERS — PILEUS 8–28 mm broad, hemispherical when young, expanding to plano-convex and applanate with depressed centre, not hygrophanous, not translucently striate, radially finely silky-fibrillose, whitish to cream-coloured. LAMELLAE adnate, whitish then pink, with serrulate concolorous edge. STIPE 55–70 × 3–5 mm, cylindrical, slightly broadened towards base, sometimes with longitudinal groove, white, pruinose at apex, white tomentum at base. CONTEXT whitish. ODOUR strong like aromatic soap. TASTE indistinct.

MICROCHARACTERS — SPORES 9.3–13.0 × 6.0–8.0 µm, Q=1.3–1.9, heterodiametrical, with 5–7 angles in side view. BASIDIA 28.5–39.0 × 10.0–11.0 µm, clavate, clampless. LAMELLAE edge sterile. CHEILOCYSTIDIA cylindrical or narrowly clavate, sometimes septate, 33.0–90.0 × 4.0–6.0 µm. PILEIPELLIS a cutis made up of hyphae 4.0–10.0 µm wide with pale intracellular pigment. CLAMPS absent.

HABITAT — On soil in broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp., *Alnus* spp.).

COLLECTION EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, VICINITIES OF THE SECOND ZOLOTYI STREAM, 43°06'37" N, 131°31'31" E, 20 Aug. 2005, leg. O. Morozova and E. Popov, LE 253788.

COMMENTS — This collection is strongly reminiscent of the very widespread *Entoloma sericellum* (Fr.) P. Kumm., from which it mainly differs by the rather persistent white colour, the lack of clamp connections, sterile lamella edge, and predominantly 5–7 angled spores. The description and illustration of

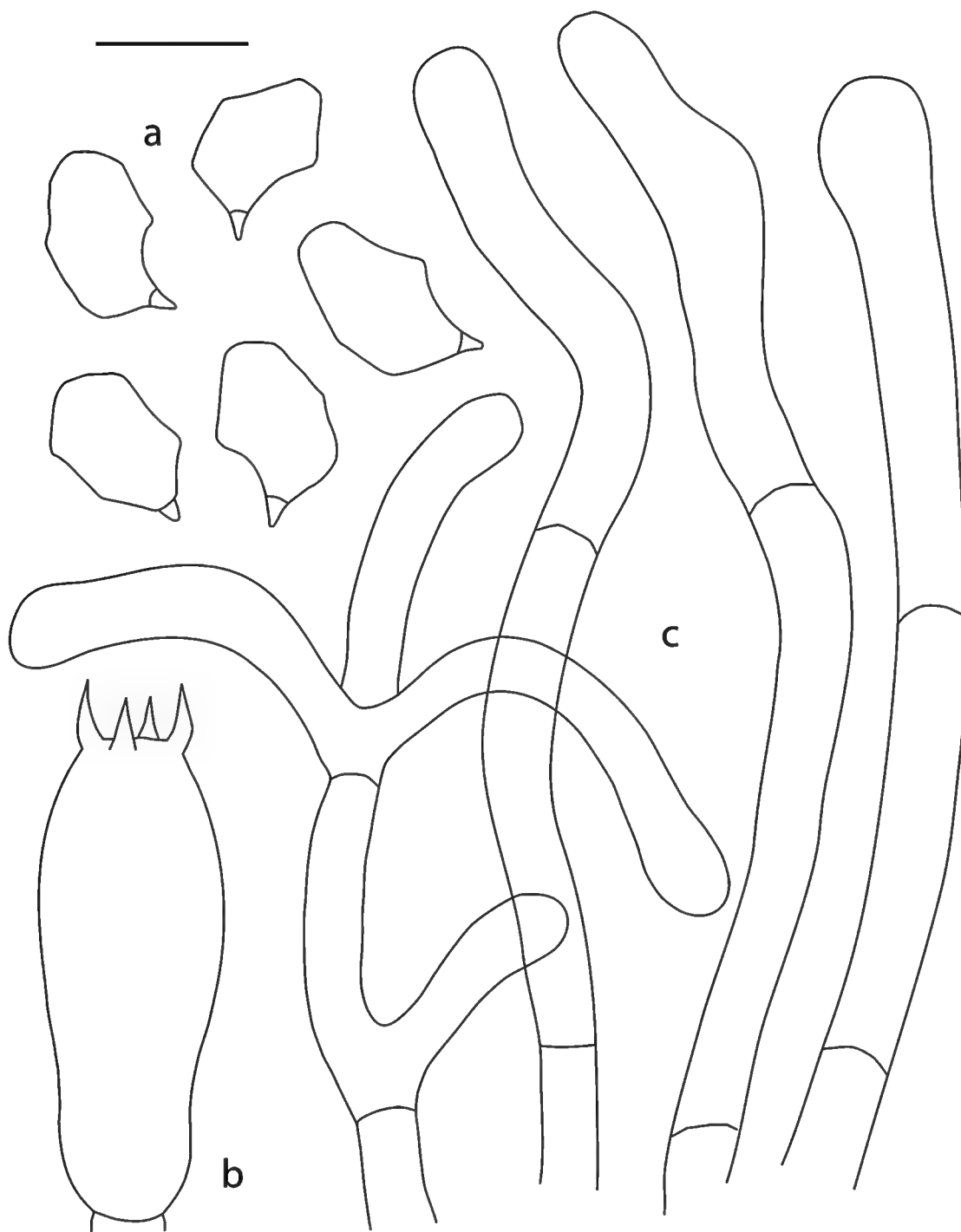


FIG. 8. *Entoloma parasericellum*. Spores (a), basidium (b), and cheilocystidia (c).
From LE 253788. Bar = 10 μ m.

E. parasericellum fit very well (Horak 1980). Our specimen differs from it only by the strong aroma with a saponaceous tinge. However, this species has only been recorded from New Guinea and Sabah to date. *Entoloma albidosimulans* G.M. Gates & Noordel. from Tasmania is also very similar, but differs by having a more differentiated pileipellis tending to a trichoderm (Gates & Noordeloos 2007). *Entoloma neosericellum* E. Horak from New Zealand is similar, differing by having abundant clamp connections (Horak 2008).

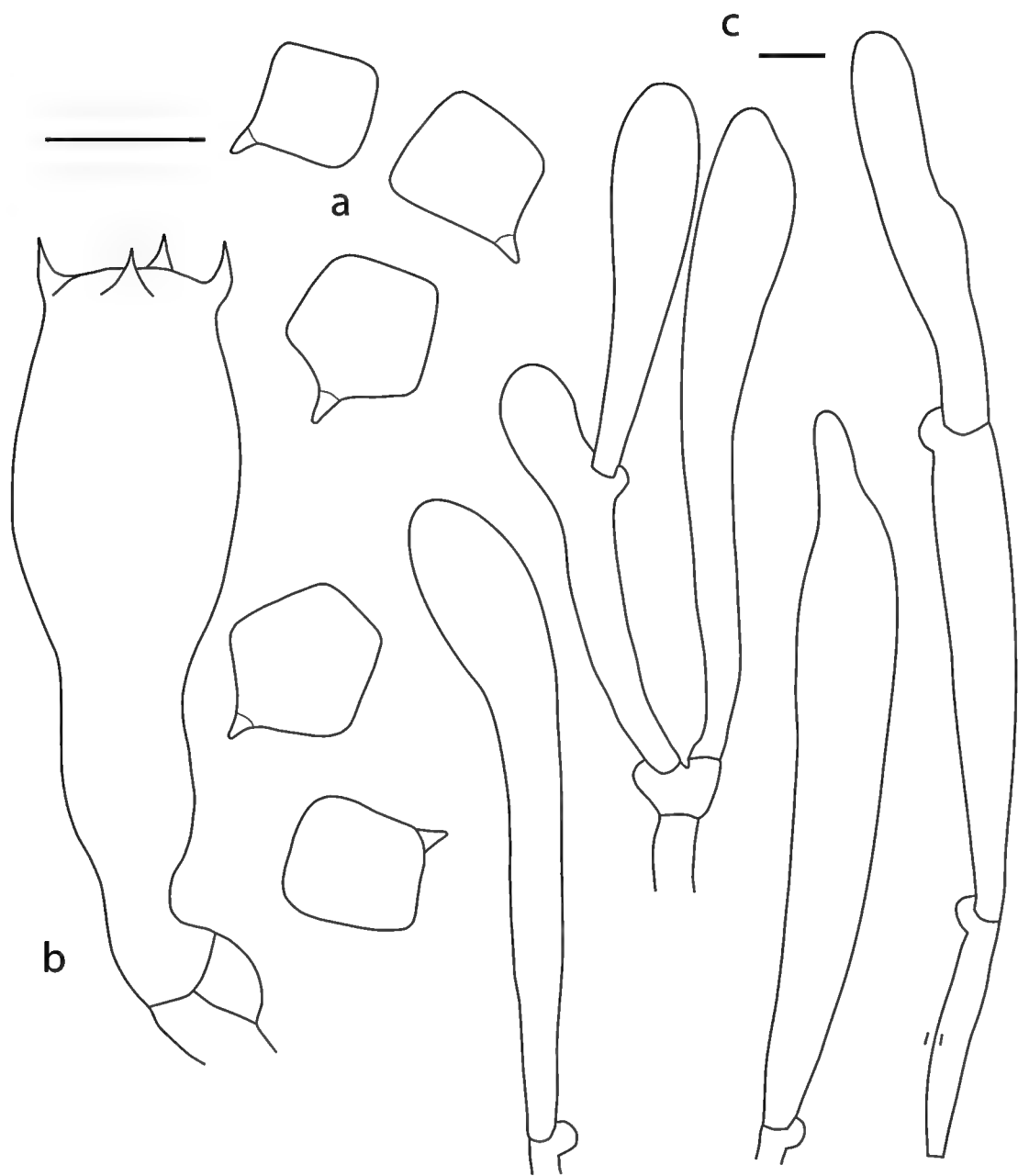


FIG. 9. *Entoloma quadratum*. Spores (a), basidium (b), and cheilocystidia (c).
From LE 253783. Bar = 10 µm.

9. *Entoloma quadratum* (Berk. & M.A. Curtis) E. Horak, Sydowia 28: 190
(1976, « 1975 »)

FIG. 9.

MACROCHARACTERS — **PILEUS** 10–40 mm broad, conical or campanulate with distinct acute papilla, hygrophanous, translucently striate, salmon pink, yellowish orange with paler serrulate margin. **LAMELLAE** adnate-emarginate, almost free, ventricose, first salmon pink then pink with concolorous or paler edge. **STIPE** 55–130 × 2–4 mm, cylindrical or slightly broadened towards base, longitudinally striate, often twisted, pruinose in the upper part, concolorous with pileus or paler, base with white tomentum. **SMELL** indistinct. **TASTE** indistinct.

MICROCHARACTERS — SPORES $8.3\text{--}10.4 \times 7.8\text{--}9.1 \mu\text{m}$, $Q=1.0\text{--}1.2$, cuboid. BASIDIA $48\text{--}62 \times 11.7\text{--}13 \mu\text{m}$, 4 spored, clamped. LAMELLAE edge sterile. CHEILOCYSTIDIA of *serrulatum*-type, with dense clusters of septate hyphae with cylindrical or narrowly clavate terminal elements $52\text{--}96 \times 10\text{--}15.5 \mu\text{m}$, without pigment. PILEIPELLIS a cutis consisting of cylindrical hyphae. Pigment intracellular. CLAMPS present.

HABITAT: on soil in the *Alnus hirsuta* and *Quercus mongolica* forest and in the broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp.).

COLLECTIONS EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, THE LEFT BANK OF THE KEDROVAYA RIVER, THE RIGHT BANK OF THE KEDROVAYA RIVER, $43^{\circ}05'56''$ N, $131^{\circ}33'21''$ E, 17 Aug. 2005, leg. E. Popov, LE 253783; THE SOUTHERN SLOPE OF THE GAKKELEVSKY MOUNTAIN RIDGE, $43^{\circ}06'10''$ N, $131^{\circ}33'34''$ E, 19 Aug. 2005, leg. R.H. Petersen; LE 253781; VICINITY OF THE SECOND ZOLOTY STREAM, $43^{\circ}06'37''$ N, $131^{\circ}31'31''$ E, 20 Aug. 2005, leg. O. Morozova, LE 253782.

COMMENTS — *Entoloma quadratum* is very easy to recognize on its salmon pink to orange basidiomes and cuboid spores. It is widespread, and locally common in North America and Japan, and extends also in eastern Asia (Horak 1976, 1980; Noordeloos & Hausknecht 2007). It was reported as *E. salmoneum* (Peck) Sacc. from Kedrovaya Pad Nature Reserve by Vassiljeva (1973).

The complex of *Entoloma serrulatum* (Fr.) Hesler

In the survey of the Kedrovaya Pad Nature Reserve, several collections have been made of taxa belonging to the cosmopolitan, and morphologically very plastic, complex of *Entoloma serrulatum*, characterized by the so-called *serrulatum*-type of lamella edge, which is a dense strand of hyphae running along the lamella edge with more or less clavate terminal endings, often in irregular, dense clusters, causing a fimbriate lamella edge when examined with a hand lens. Usually these elements or “cheilocystidia” are filled with a deep blue or blackish blue, rarely brown or purple, intracellular pigment. Many species have been distinguished in this group, mainly based on colour differences of the pileus and stipe combined with slight differences in spore size and shape. At present we feel that a thorough revision using molecular markers would contribute to a better understanding of the diagnostic value of these characters.

The following collections have been named using existing literature:

10. *Entoloma gomerense* Wölfel & Noordel., Öst. Z. Pilzk. 10: 192 (2001)

FIG. 10, PLATE 1.9

MACROCHARACTERS — PILEUS 7–10 mm broad, plano-convex with depressed centre, slightly hygrophanous, translucently striate, very dark grayish blue with purple or brown tinge in centre and stripes, almost white between them,

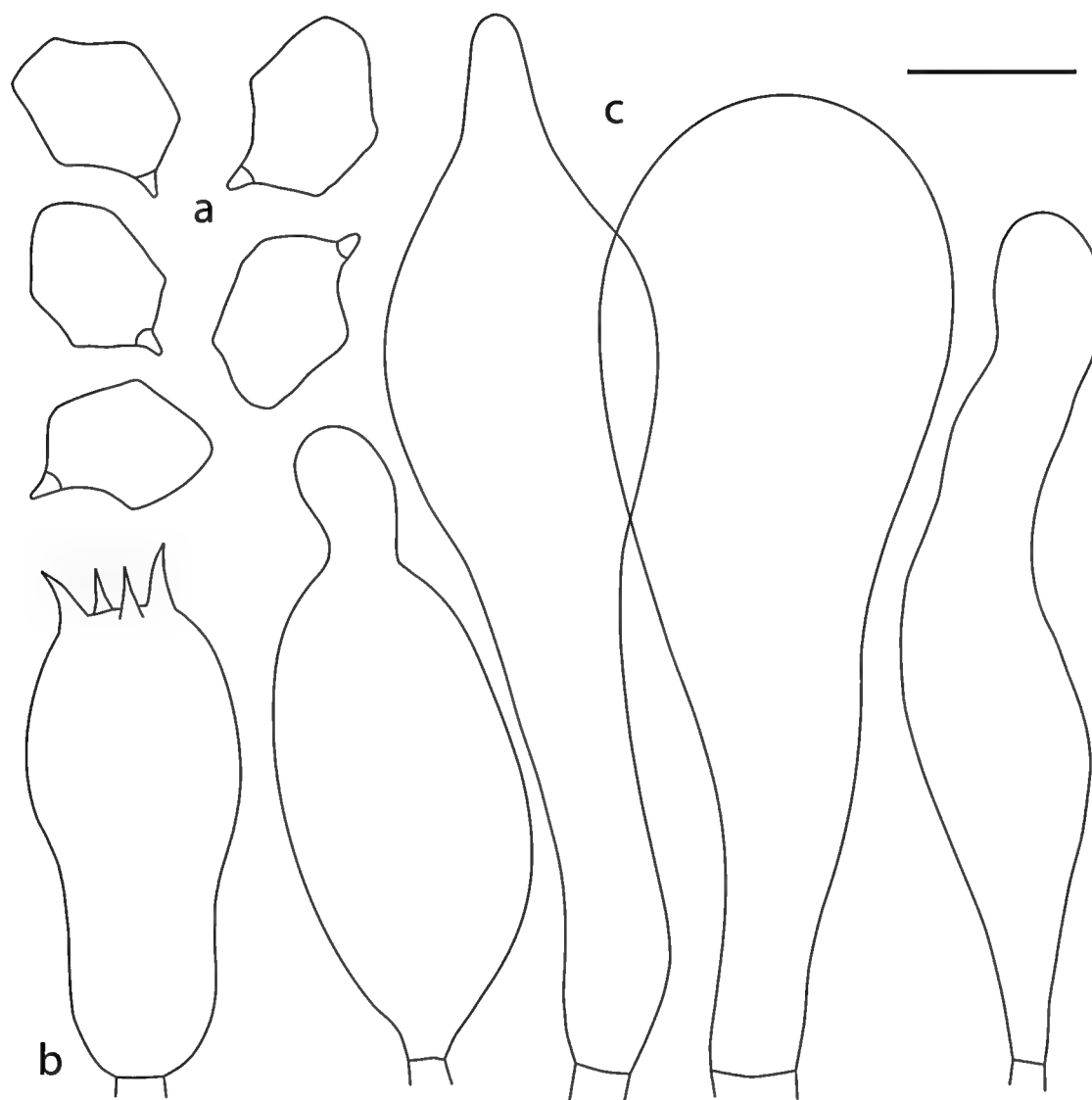


FIG. 10. *Entoloma gomerense*. Spores (a), basidium (b), and cheilocystidia (c).
From LE 253784. Bar = 10 μ m.

covered by grayish blue scales. LAMELLAE adnate-emarginate with small decurrent tooth, grayish pink with serrulate blackish purple edge. STIPE 22–25 \times 1 mm, cylindrical, dark grayish blue, polished, glabrous, base with white tomentum. CONTEXT concolorous with the surface, whitish in the inner part. ODOUR indistinct. TASTE indistinct.

MICROCHARACTERS — SPORES 8.5–10.5(11.7) \times 6.5–8.5 μ m, $Q=(1.1)1.3$ –1.5, heterodiametrical, with 5–6 angles in side view. BASIDIA 22–26 \times 9–12 μ m, clavate to broadly ellipsoid, clampless. LAMELLAE edge sterile. CHEILOCYSTIDIA 20–73 \times 8–22 μ m, broadly clavate or lageniform with dark intracellular pigment. PILEIPELLIS a cutis with transition to a trichoderm. Pigment intracellular. CLAMPS absent.

HABITAT — on soil and decayed wood in the flood plain forest.

COLLECTION EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, THE RIGHT BANK OF THE KEDROVAYA RIVER, 43°05'56" N, 131°33'21" E, 17 Aug. 2005, leg. O. Morozova, LE 253784.

COMMENTS — The small dark grayish blue basidiomes with deeply translucently striate pileus and blackish blue, *serrulatum*-type lamella edge are distinctive for this tiny *Cyanula*. Originally described from the Island of Gomera, Islas Canarias, Spain, it now has also been recorded from a few European localities (Noordeloos 2004). It seems to prefer moist places with mosses and peaty soil.

11. *Entoloma caesiocinctum* (Kühner) Noordel., Persoonia 11(4): 470 (1982)

FIG. 11

MACROCHARACTERS — PILEUS 20–25 mm broad, infundibuliform, slightly hygrophanous, translucently striate, radially fibrillose, dark grayish blue and squamulose at centre, grayish brown from the centre becoming grayish blue at margin. LAMELLAE subdecurrent or arcuate, first blue, then grayish pink with serrulate dark blue edge. STIPE 55–60 × 3–5 mm, cylindrical or compressed with longitudinal groove, dark blue or grayish blue, glabrous, polished, base with white or grayish tomentum. CONTEXT concolour with the surface, inner part whitish. ODOUR spicy. TASTE of starch.

MICROCHARACTERS — SPORES 7.5–11.0 × 5.5–7.5 µm, Q=1.2–1.6, heterodiametrical, with 5–7 angles in side view. BASIDIA 21–31 × 8–12 µm,

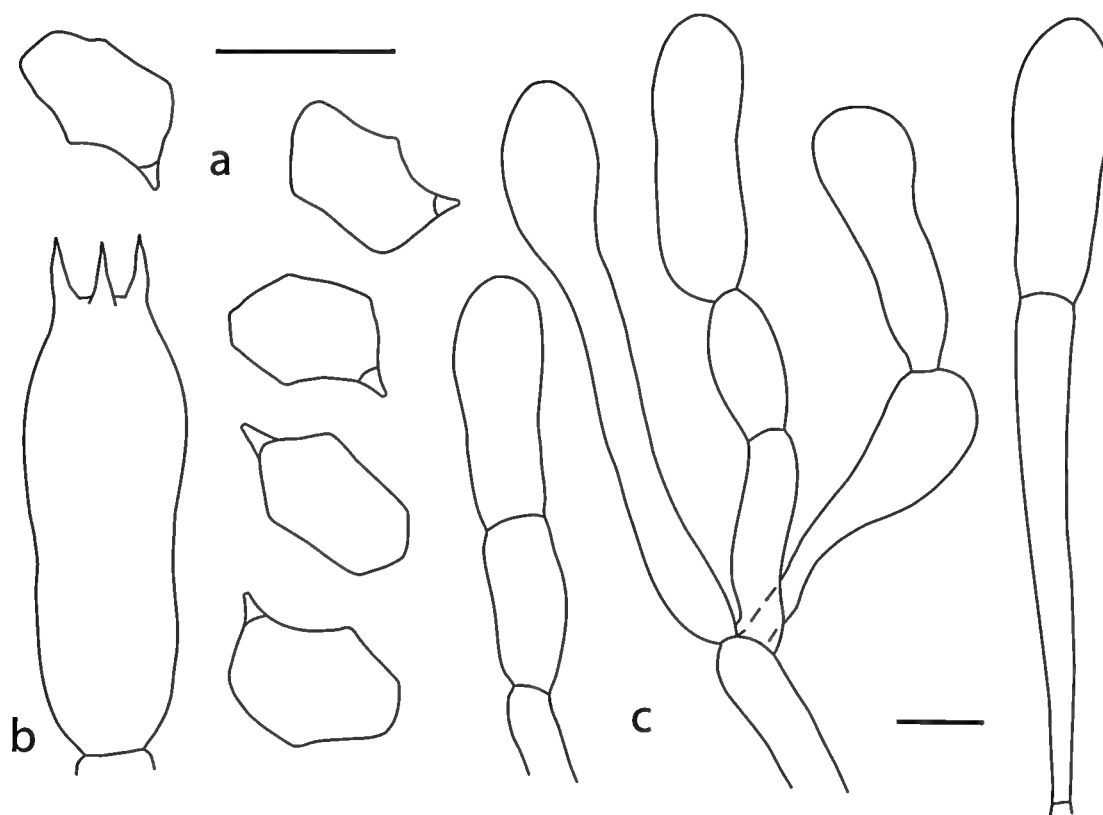


FIG. 11. *Entoloma caesiocinctum*. Spores (a), basidium (b), and cheilocystidia (c).

From LE 253786. Bar = 10 µm.

clavate, clampless. LAMELLAE edge sterile. Cheilocystidia of *serrulatum*-type, with dense clusters of septate hyphae with cylindrical or narrowly clavate terminal elements $50\text{--}120 \times 6\text{--}10 \mu\text{m}$, with bluish intracellular pigment. PILEIPELLIS a cutis with transition to a trichoderm. Pigment intracellular. CLAMPS absent.

HABITAT — On soil in broad-leaved forest (*Quercus mongolica*, *Tilia amurensis*, *Acer* spp., *Alnus* spp.).

COLLECTIONS EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, THE RIGHT BANK OF THE KEDROVAYA RIVER, $43^{\circ}05'56''$ N, $131^{\circ}33'21''$ E, 17 Aug. 2005, leg. O. Morozova, LE 253785; PRIMORSKY TERRITORY, Kedrovaya Pad Nature Reserve, VICINITIES OF THE SECOND ZOLOTY STREAM, $43^{\circ}06'37''$ N, $131^{\circ}31'31''$ E, 20 Aug. 2005, leg. O. Morozova, LE 253786.

COMMENTS — The above collections could be identified as *E. caesiocinctum* due to their predominantly brown, translucently striate pileus, but our specimens differ from the typical *E. caesiocinctum* by the clitocyboid form of the basidiome and slightly smaller spores.

12. *Entoloma violaceoserrulatum* Noordel., Fungi Europaei, 5a: 1038 (2004)

FIG. 12

MACROCHARACTERS — PILEUS 26–40 mm broad, infundibuliform, not hygrophanous, not translucently striate, brownish gray with violaceous tinge, entirely squamulose. LAMELLAE decurrent, grayish pink with serrulate violaceous edge. STIPE 55–70 \times 3–5 mm, cylindrical, slightly broadened towards base, with longitudinal groove, bluish gray with violaceous tinge, white at apex, squamulose, base with white tomentum. CONTEXT whitish. SMELL indistinct. TASTE indistinct.

MICROCHARACTERS — SPORES $8.0\text{--}10.5 \times 6.0\text{--}8.0 \mu\text{m}$, $Q=1.1\text{--}1.6$, heterodiametrical, with 5–6 angles in side view. BASIDIA $22\text{--}45 \times 11\text{--}15 \mu\text{m}$, clavate to broadly ellipsoid, clampless. LAMELLAE edge sterile. CHEILOCYSTIDIA of *serrulatum*-type, with dense clusters of septate hyphae with cylindrical or clavate terminal elements $50\text{--}120 \times 10\text{--}22 \mu\text{m}$, with bluish intracellular pigment. PILEIPELLIS a cutis with transition to a trichoderm, made up of inflated terminal elements, $40\text{--}70 \times 5\text{--}22 \mu\text{m}$ with blue, intracellular pigment. Brilliant granules abundant in pilei- and hymenophoral-trama. CLAMP CONNECTIONS absent.

HABITAT — On soil in the flood plain forest.

COLLECTION EXAMINED — RUSSIA. PRIMORSKY TERRITORY: Kedrovaya Pad Nature Reserve, THE RIGHT BANK OF THE KEDROVAYA RIVER, $43^{\circ}05'56''$ N, $131^{\circ}33'21''$ E, 17 Aug. 2005, leg. O. Morozova, LE 253787.

COMMENTS — The description of *Entoloma violaceoserrulatum* (originally from Finland) characterized by the violaceous tinges in both the pileus and stipe fits this collection well (Noordeloos 2004).

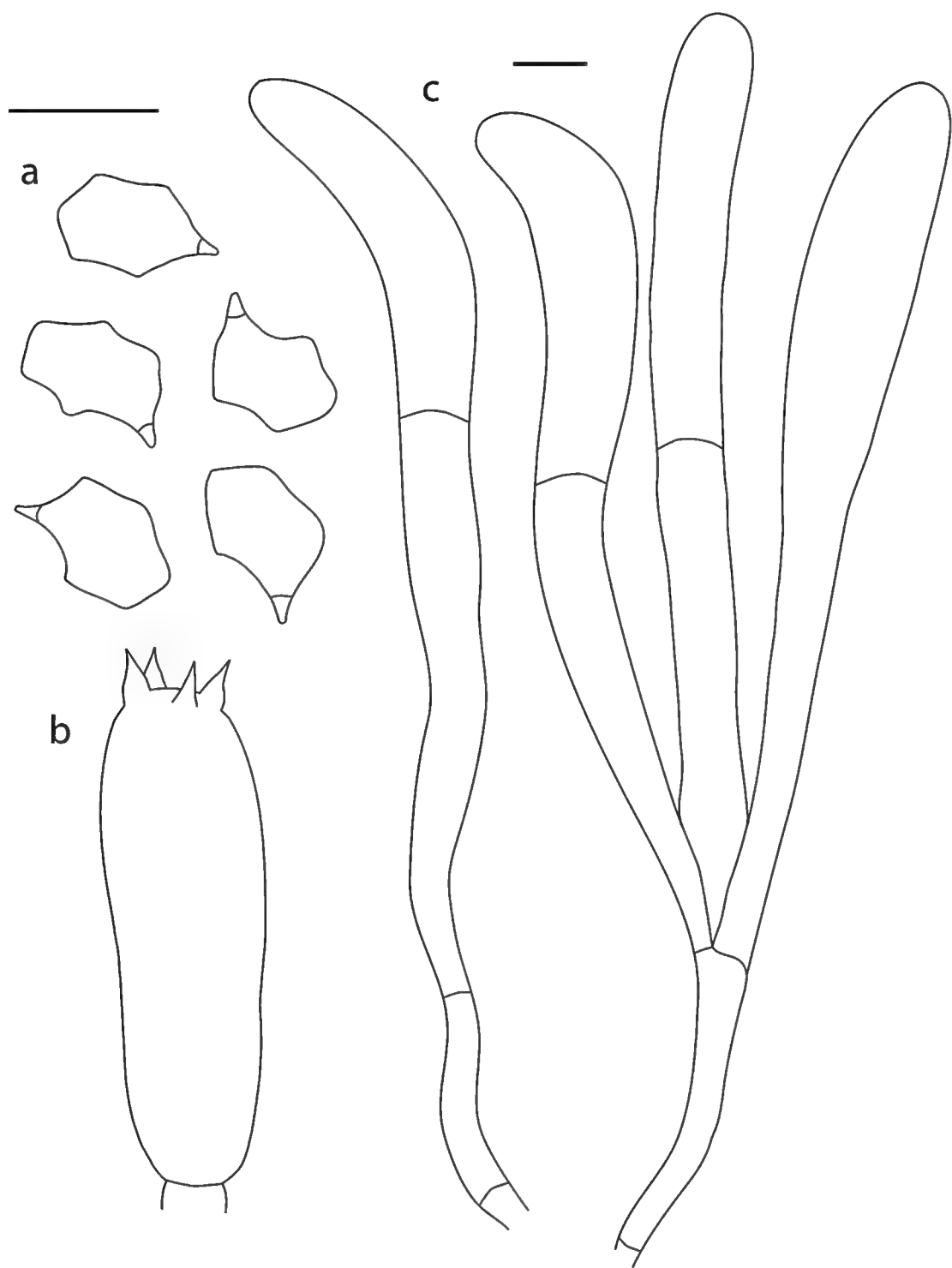


FIG. 12. *Entoloma violaceoserrulatum*. Spores (a), basidium (b), and cheilocystidia (c).
From LE 253787. Bar = 10 μ m.

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Literature cited

- Azbukina ZM, Kharkevich SS (eds.). 1984. Flora Verkhneussuriyskogo stacionara (Yuzhny Sikhote-Alin). Vladivostok. (In Russian).
- Berkeley MJ. 1859 (“1860”). Fungi pp. 241-282, in JD Hooker (ed.). Flora Tasmaniae. London, Lovell Reeve.
- Bulakh EM. 2005. Investigators and results of study of the agaricoid mushrooms of Russian Far East. / Fungi in natural and anthropogenic ecosystems: Proceedings of the international conference dedicated to the centenary of the beginning by Professor A.S. Bondartsev his research activity at the V.L. Komarov Botanical Institute RAS (24–28 April, 2005, Saint Petersburg). Vol. 1. pp. 73–77. (In Russian).
- Co-David DLV, Langeveld D, Noordeloos ME. 2009. The molecular phylogeny and spore evolution of *Entolomataceae*. *Persoonia* 23: 147–176.
- Egorova LN (ed.). 2002. Flora, mycobiota i rastitelnost' Lazovskogo zapovednika (Primorsky krai). Vladivostok: Russky Ostrov. (In Russian).
- Gates GM, Noordeloos ME. 2007. Preliminary studies in the genus *Entoloma* in Tasmania – I. *Persoonia* 19: 157–226.
- Hesler LR. 1967. *Entoloma* in southeastern North America. Beihefte Nova Hedwigia 23. J. Cramer, Germany.
- Horak E. 1973. Fungi Agaricini Novazelandiae I–V. Beihefte Nova Hedwigia 43. J. Cramer, Germany.
- Horak E. 1980. *Entoloma* (*Agaricales*) in Indomalaya and Australasia. Beihefte Nova Hedwigia 65. J. Cramer, Germany.
- Horak E. 2008. *Agaricales* of New Zealand 1: *Pluteaceae* – *Entolomataceae*. The fungi of New Zealand vol. 5. Fungal Diversity Press, Hong Kong.
- Largent DL. 1977. The genus *Leptonia* on the Pacific Coast of the United States including a study of North American types. *Bibliotheca Mycologica* 55. J. Cramer, Germany.
- Largent DL. 1994. *Entolomatoid* fungi of the Pacific Northwest and Alaska. Mad River Press, USA.
- Manimohan P, Noordeloos ME, Dhanya AM. 2006. Studies on the genus *Entoloma* (*Basidiomycetes*, *Agaricales*) in Kerala State, India. *Persoonia* 19: 45–94.
- Morozova OV. 2007. First data on the genus *Entoloma* (*Entolomataceae*, *Agaricales*) from Kamchatka Peninsula // XV Congress of European Mycologists, Abstracts. P. 136.
- Noordeloos ME. 1981. Introduction to the taxonomy of the genus *Entoloma* sensu lato (*Agaricales*). *Persoonia* 11: 121–151.
- Noordeloos ME. 1992. *Entoloma* s.l. Fungi Europaei, vol. 5. Giovanna Biella, Italy.
- Noordeloos ME. 2004. *Entoloma* s.l. Fungi Europaei, vol. 5a. Edizione Candusso, Italy.
- Noordeloos ME, Hausknecht A. 2000. Three new *Entolomataceae* (*Agaricales*) from Italy. *Il Bollettino Gruppo Micologico G. Bresadola* 43(3): 23–33.
- Noordeloos ME, Gates GM. 2009. Preliminary studies in the genus *Entoloma* in Tasmania II. *Cryptogamie, Mycologie* 30: 107–140.
- Noordeloos ME, Hausknecht A. 2007. The genus *Entoloma* (*Basidiomycetes*, *Agaricales*) of the Mascarenes and Seychelles. *Fungal Diversity* 27: 111–144.

- Noordeloos ME, Liiv V. 1992. New Taxa of *Entoloma* (*Basidiomycetes*, *Agaricales*) from Estonia and Karelia. *Persoonia* 15: 23–31.
- Romagnesi H, Gilles G. 1979. Les Rhodophylles des forêts côtières du Gabon et de la Côte d'Ivoire. *Beihefte Nova Hedwigia* 59.
- Vasilyev NG, Kharkevich SS, Shibnev YuB. 1984. Zapovednik "Kedrovaya Pad". Moscow. (In Russian).
- Vassiljeva LN, Bezdeleva TA (eds.). 2006. Flora, vegetation and mycobiota of the reserve "Ussuriysky". Vladivostok. (In Russian).
- Vassiljeva LN. 1973. Die Blätterpilze und Röhrlinge (*Agaricales*) von Primorsky Region. Leningrad. (In Russian).
- Vila J, Caballero F. 2007. *Entoloma* nuevos o interesantes de la Península Ibérica. Fungi non delineati raro vel haud perspecte et explorate descripti aut definite picti. Pars XXXVIII. Edizione Candusso, Italy.
- Wölfel G, Noordeloos ME. 1997. *Entoloma ritae*, eine neue rosafarbige *Entoloma* aus dem Trentin. *Boll. Gr. micol. G. Bres.*, N.S. 40: 491–495.

***Lylea indica*: a new hyphomycete species from India**

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Abstract — A new hyphomycete species, *Lylea indica*, from Nagzira, Vidharba region of Maharashtra state in India found on dead culms of *Bambusa arundinacea* is here described.

Key words — fungal diversity, anamorphic fungus, taxonomy

Introduction

Morgan-Jones (1975) established *Lylea* (type species *L. catenulata* Morgan-Jones) on twigs of *Pinus taeda* L. collected in Auburn, Alabama. Four species have been described in the genus (Morgan-Jones 1975, Mercado et al. 1977, Chang 1999, McKenzie 2009). A fifth *Lylea* species has been found among fungi collected from forests of Vidarbha region in Maharashtra state. The new species is illustrated and described below.

Materials & methods

A Nikon Stereozoom microscope (Model SMZ-1500 with Digi-CAM) was used to study patterns of colonies growing on herbarium specimens. Semi-permanent microscopic slides were prepared by making scrape mounts from the specimens. Specimens were mounted in lactophenol-cotton blue for micrometric details using an Olympus CX-41. Measurements of fungal structures were taken with a calibrated ocular micrometer. Illustrations were prepared using camera lucida. Holotype material is deposited in Ajrekar Mycological Herbarium (AMH), MACS' Agharkar Research Institute, Pune, India (AMH, according to Holmgren et al. 1990).

Attempts to culture the described species on V-8 Juice Agar and Potato Dextrose Agar (Tuite 1969) were unsuccessful.

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Taxonomic description

Lylea indica K.G. Karand. & S.K. Singh, sp. nov.

FIGS 1–4

MYCOBANK MB 515199

Lylea catenulata similis sed conidiophoris macronematis et conidiis in catenis simplicibus.

HOLOTYPE — on dead culms of *Bambusa arundinacea* Willd. (*Poaceae*), India, Nagzira, Vidarbha, Maharashtra, 21.12.1983, K.G. Karandikar, 6632: AMH.

ETYMOLOGY — *indica* refers to the country of origin.

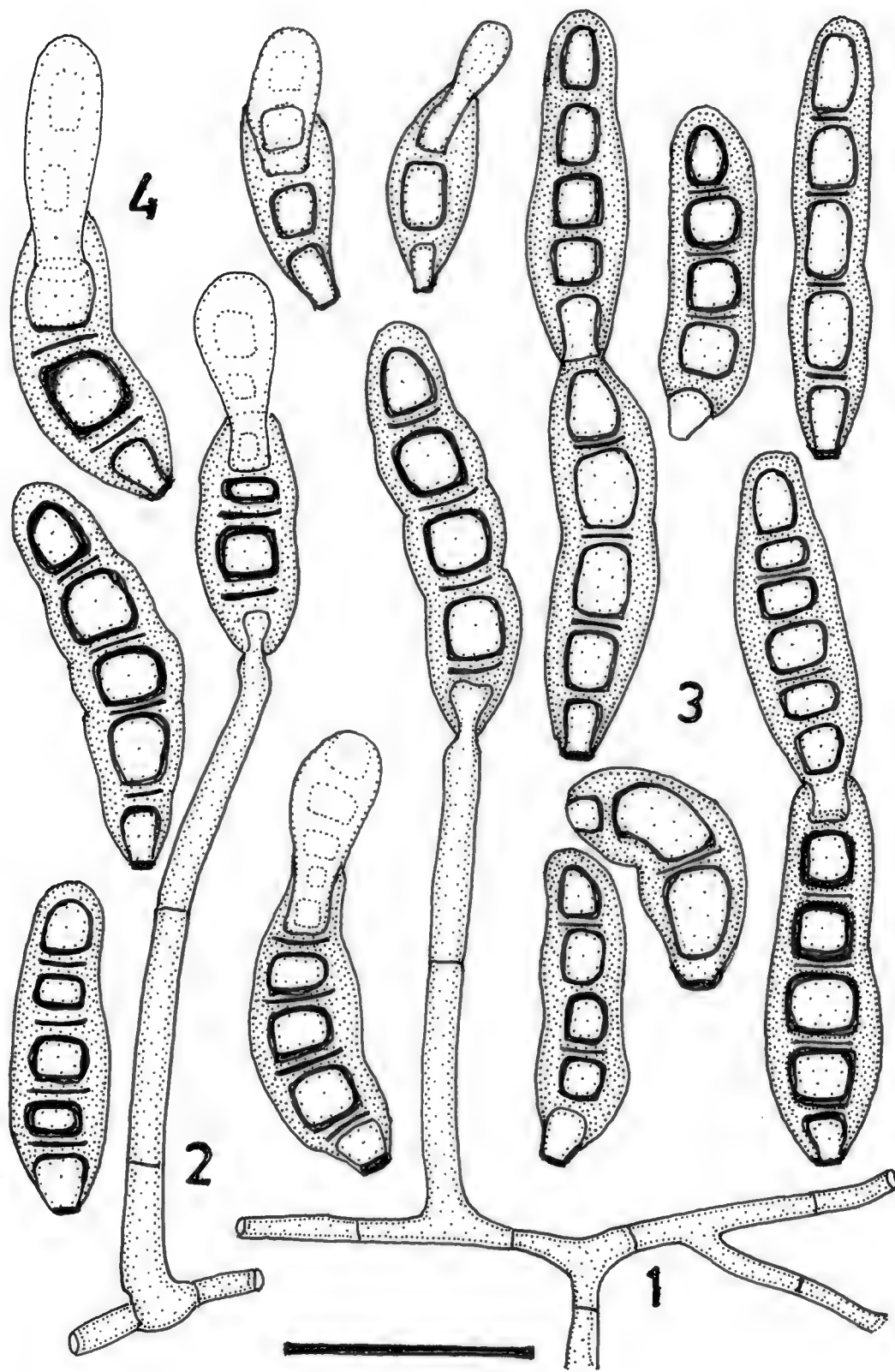
COLONIES effuse. *Mycelium* brown partly superficial. HYPHAE branched, septate, pale brown, 1.5–2.0 µm wide. CONIDIOPHORES determinate, macronematous, mononematous, simple, cylindrical, straight or flexuous, unbranched, pale-brown, 1–4 septate, smooth, 24–65 × 1.5–2.0(–3.5) µm. CONIDIOGENOUS CELLS integrated, terminal, determinate, monoblastic and terminal cells of conidia, forming short, acropetal chains. The growth of conidiophores ceases with the formation of the conidium at its apex. The successive conidia then develop on the terminal cell of previously formed conidium. CONIDIA acrogenous, singly short catenate, mid brown to brown, smooth, cylindrical to fusiform, 3–7 pseudoseptate, 10–35.5(–21) × 5.5–11.5(–8.5) µm with thick black, conspicuous lamellae and with constrictions at septa or shows wavy margin.

COMMENT—*Lylea indica* shows affinity with *L. catenulata* in having pseudoseptate conidia with lamellae that develop in short, acropetal chains. However, *L. indica* produces macronematous conidiophores and conidia that always form unbranched chains resulting from the conidia successively developing from the terminal cell of an earlier conidium in the chain; conidia never arise from intercalary cells of a conidium as is found in *L. catenulata*. In addition, conidia in *L. indica* are considerably shorter (10–35.5 µm) than those of *L. catenulata* (40–67(–120) µm).

The new *Lylea* species differs from the other members of the genus [e.g., *L. tetracoila* (Corda) Hol.-Jech. (Holubová-Jechová 1978), *L. palmicola* Mercado et al. (Mercado et al. 1997)] in producing up to seven pseudoseptate conidia compared to 2–4 in (*L. tetracoila*) and 0–4 (*L. palmicola*). *Lylea indica* differs from *L. rhopalostylidis* McKenzie (McKenzie 2009) in producing significantly smaller conidia and conidiophores as well as having conidia with thick black conspicuous lamellae all along the mature conidial inner cell walls.

Acknowledgements

We are indebted to Dr. Lei Cai, Novozymes China and Dr. José C. Dianese, Departamento de Fitopatologia, Universidade de Brasília, Brasília, DF, Brazil for kindly reviewing the manuscript and Director, Agharkar Research Institute (ARI), Pune for providing facilities. S.K. Singh thanks the Department of Science and Technology (DST), Government of India, New Delhi for providing financial support for setting up



FIGS.1-4. *Lylea indica*

1. Vegetative mycelium connected to a conidiophore with a terminal conidium.
2. Conidiophore bearing an apically germinated conidium.
3. Conidial chain
4. Apically proliferating conidia. Scale bar = 20µm.

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Literature cited

- Chang HS. 1999. Three dematiaceous hyphomycetes from Taiwan. Bot. Bull. Acad. Sin. 40: 247–250.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum: part I: The herbaria of the world. 8th ed. Bronx, NY Botanical Garden.
- Holubová-Jechová V. 1978. Lignicolous hyphomycetes from Czechoslovakia. 5: *Septonema*, *Homiactella* and *Lylea*. Folia Geobot. Phytotax. 13: 421–442.
- McKenzie EHC. 2009. A new species of *Lylea* (hyphomycetes) on *Rhopalostylis* (Arecaceae) in New Zealand. Mycotaxon 109: 39–42.
- Mercado-Sierra Á, Figueras MJ, Gené J. 1997. New or rare hyphomycetes from Cuba VIII. Species of *Lylea*, *Phaeoisaria*, *Arxiella*, *Graphium*, *Periconia* and *Ramichloridium*. Mycotaxon 63: 369–375.
- Morgan-Jones G. 1975. Notes on hyphomycetes. VIII. *Lylea*, a new genus. Mycotaxon 3: 129–132.
- Tuite J. 1969. Plant pathological methods in fungi and bacteria. Burgess Publishing Company, Minneapolis.

**The genus *Volvariella* in Spain:
V. dunensis comb. & stat. nov.
and observations on *V. earlei***

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Abstract — *Volvariella nigrovolvacea* var. *dunensis* is raised to the species rank, and its delimitation from similar taxa is discussed. *Volvariella earlei* is recorded for the second time in Europe, and its taxonomy, nomenclature, and distribution are briefly discussed. A key to the Iberian species of *Volvariella* is provided.

Key words — Agaricales, Agaricomycetes, biodiversity, Pluteaceae

Introduction

In recent years the genus *Volvariella* Speg. (Agaricales, Basidiomycota) has been the subject of several regional (Justo & Castro 2004, Justo et al. 2005) or taxonomic (Vila et al. 1999) studies in the Iberian Peninsula (Spain, Portugal). After revising the collections deposited in several Iberian herbaria and identifying newly collected material, we have published an annotated checklist of the genus in our area (Justo & Castro 2010). According to our study 12 taxa of *Volvariella* occur in the Iberian Peninsula and Balearic Islands.

This paper presents additional taxonomic notes and observations resulting from our work on *Volvariella*. We raise *Volvariella nigrovolvacea* var. *dunensis* to species rank, based on morphological and ecological differences from related species, *V. nigrovolvacea* Kosina and *V. volvacea* (Bull.) Singer. *Volvariella earlei* is mentioned for the first time in our area and for the second time in Europe. Both species are fully described and their taxonomy and distribution are briefly discussed.

A key to all members of the genus *Volvariella* in the Iberian Peninsula and Balearic Islands is provided.

Material and methods

Standard methods for describing the basidiocarps were applied, using the terminology of Vellinga (1988) and Boekhout (1990). Color annotations for the macroscopic descriptions are from Munsell Color Company (2000). The notation [60, 2, 2] indicates that measurements were made on 60 basidiospores in 2 samples from 2 collections. At least 10 measurements per collection were performed for other microscopic features such as basidia (excluding sterigmata), cystidia, and pileipellis elements. Microscopical preparations were mounted in Congo Red, then the excess dye was removed and 5% KOH was added. The following abbreviations are used in the descriptions: avl for average length, avw for average width, Q for quotient of length and width and avQ for average quotient. Extreme measurements are indicated within parentheses. Herbarium acronyms follow Holmgren & Holmgren (1998) except “SCAT”, which is used for the “Societat Catalana de Micologia” herbarium.

Taxonomy

1. *Volvariella dunensis* (Vila, Àngel & Llimona) Justo & M.L. Castro, comb. & stat. nov.

FIG. 1

MYCOBANK MB 514014

BASIONYM: *Volvariella nigrovolvacea* var. *dunensis* Vila, Àngel & Llimona, Rev. Catalana Micol. 22: 131. 1999.

PILEUS 35–100 mm, subglobose or campanulate when young, later plano-convex, without umbo; surface radially fibrillose, especially towards margin, sometimes radially fissurate; gray or bluish gray [approx. Mu. GLEY 2 4/1 “bluish gray”, 5/1 “dark bluish grey”], with some brown or grayish-brown tint in older specimens; margin entire, not striate. LAMELLAE crowded, free, (broadly) ventricose; up to 10 mm broad; white when young, later pink, with white flocculose edges. STIPE 25–50 × 9–14 mm, cylindrical or narrowly clavate, with slightly broadened base (up to 20 mm); white; pubescent in young specimens, then glabrous. VOLVA saccate, membranous, irregularly lobed fragile; white, sometimes leaving small patches on pileus. CONTEXT in pileus white, with dark grey tints under pileipellis especially in older specimens; in stipe white. SMELL fungoid. TASTE not recorded. SPORE PRINT not recorded.

BASIDIOSPORES [60, 2, 2] 7–8.5 × 4.5–6 µm, avl × avw = 7.7–7.9 × 5.1–5.2 µm, Q = 1.3–1.7(–1.8), avQ = 1.5–1.55, ellipsoid to oblong. BASIDIA 20–35 × 7–15 µm, 4-spored, broadly clavate. PLEUROCYSTIDIA (34–)50–95(–108) × (16–)20–45(–50) µm, clavate, (narrowly) utriform, obovoid; colorless; with thin, smooth walls; fairly abundant. CHEILOCYSTIDIA 20–80 × 15–60 µm, clavate or utriform, without apical appendages, colorless; with thin, smooth walls; abundant and relatively crowded. PILEIPELLIS a cutis made up of cylindrical elements (20–)

50–275 × 10–35(–50) µm, colorless or with brown intracellular pigment; with thin, smooth walls. STIPITIPPELLIS a cutis; hyphae 5–20 µm wide, cylindrical, colorless or with brown pigment; with thin, smooth walls. CAULOCYSTIDIA 20–75 × 10–25 µm, clavate, utriform, lageniform, flexuous, sometimes with elongated or subcapitate apex, without internal septa, colorless or with brown pigment; with thin, smooth walls. CLAMP CONNECTIONS absent in all tissues.

ECOLOGY AND DISTRIBUTION — In open dunes with most of the basidiocarp growing deeply buried in the sand. Known from two localities on the Mediterranean coast of Spain (Barcelona: Viladecans, Prat de Llobregat). January–February.

COLLECTIONS EXAMINED—**SPAIN: Barcelona:** Viladecans (Baix Llobregat), in open dunes, 5.II.1998, J. Vila & F. Àngel, SCAT 3512 (Holotype); El Prat de Llobregat, El Pinar, in open dunes, 8.II.1997, F. Àngel, SCAT 3513.

COMMENTS—*Volvariella dunensis* was first described as a variety of *V. nigrovolvacea*. However examination of the Spanish collections revealed important morphological and ecological differences that separate this taxon from *V. nigrovolvacea* as well as from the morphologically similar *V. volvacea*.

Volvariella nigrovolvacea is an obscure and little-known species originally described from grassy fields in the Czech Republic (Kosina 1974). Its main characteristics are the relatively large basidiomes (pileus 100–150 mm), fibrillose pileus, glabrous stipe, and a well-developed, saccate, grey-brown volva. As already noted by Boekhout (1990), the only difference from *V. volvacea* seems to be the glabrous stipe.

The original microscopical description of *V. nigrovolvacea* could be more complete, as Kosina (1974) provided data only for the spores (“7–8.5 × 4.5–5.5 µm”) and cheilocystidia (“ampulliform, fusiform, colorless, 47–70 × 13–18 µm, rare”). The type collection is lost (Dr. Jan Holec, pers. com.), preventing further microscopic study. It seems likely that *V. nigrovolvacea* is a synonym of *V. volvacea*, but this should be confirmed by new collections of *V. nigrovolvacea* from the type locality.

Contu & La Rocca (1999) described a collection identified as *V. nigrovolvacea* from Sardinia from dunes under *Juniperus*. These authors described a taxon with relatively small basidiocarps (pileus 15–50 mm), which contrast with the larger basidiocarps (pileus 100–150 mm) mentioned in the original description of *V. nigrovolvacea* (Kosina 1974).

In the Sardinian collections the pleurocystidia are described as fusiform or utriform and the cheilocystidia as fusiform, sometimes mucronate. Because of the incomplete microscopical description of *V. nigrovolvacea*, and the differences in macroscopical and ecological characters it is uncertain whether the taxon described by Contu & La Rocca (1999) is really the same as the one described by Kosina (1974).

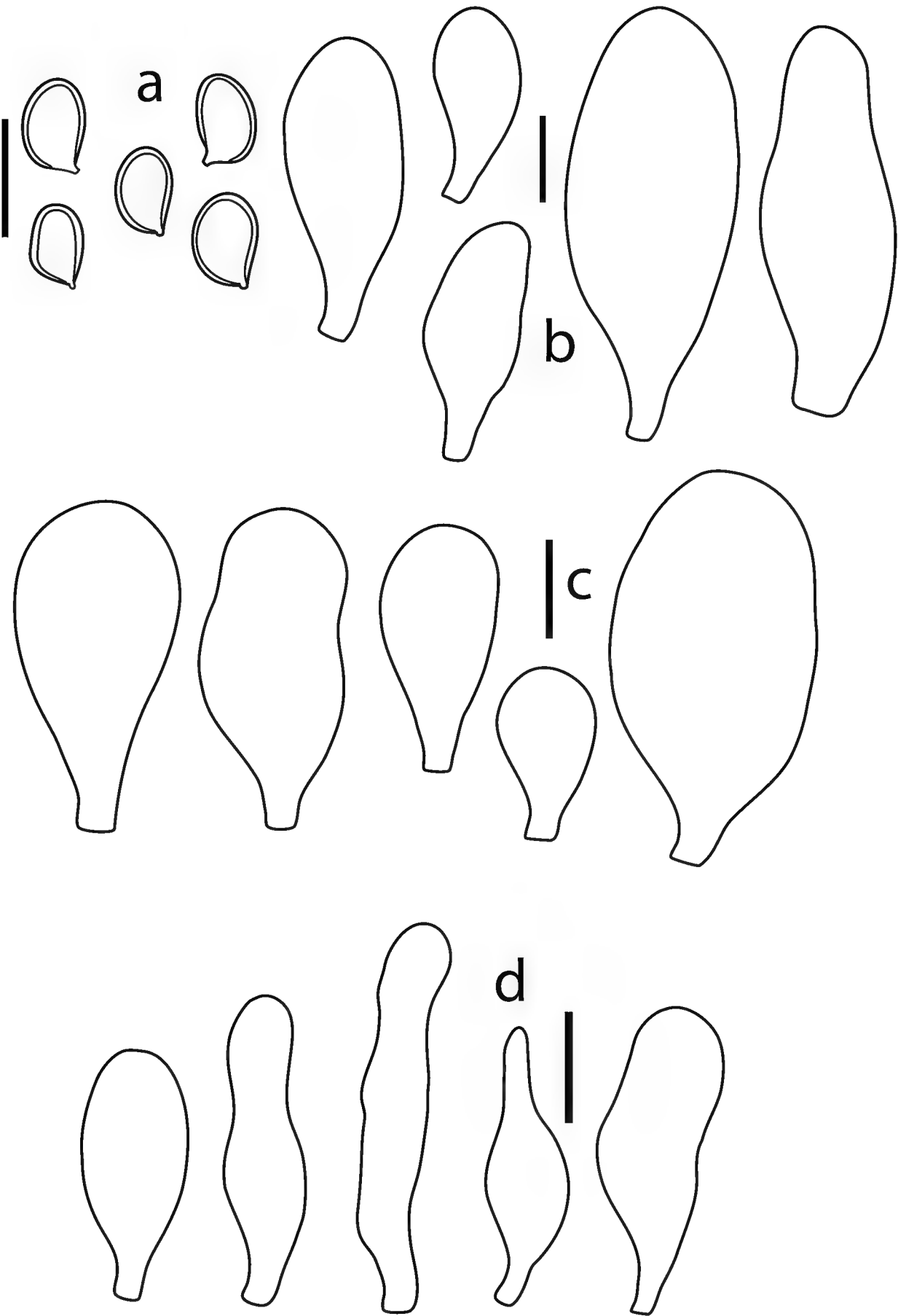


FIG 1. *Volvariella dunensis*.
a = spores; b = pleurocystidia; c = cheilocystidia; d = caulocystidia.
All from SCAT 3512 (Holotype). Scale bars a = 10 μ m; b, c, d = 20 μ m.

Although *V. dunensis* was first described as a variety of *V. nigrovolvacea*, these taxa differ in ecology and morphology of the volva and cheilocystidia. Moreover, the doubtful and uncertain status of *V. nigrovolvacea* contributed to our separating it from the well described and delimited *V. dunensis*.

Volvariella volvacea and *V. dunensis* resemble each other macroscopically, but *V. volvacea* has a well-developed grey-brown volva and fruits on organic-rich substrates (leaves, compost, sawdust) usually during summer and spring, at least in Europe (Boekhout 1990, Justo & Castro 2010). On the other hand, *V. dunensis* has a whitish, rather fragile volva and fruits on open dunes and is not directly associated with accumulations of organic matter during winter.

Cystidial shapes also differ in the two species. *Volvariella volvacea* has fusiform, lageniform, clavate or utriform pleurocystidia and cheilocystidia, usually with elongated apices, mucronate or with an apical flexuous appendage (data from the Spanish collections; Justo & Castro 2010). In *V. dunensis*, pleurocystidia and cheilocystidia are predominantly clavate, obovoid, or (narrowly) utriform, without elongated apices or appendages. The caulocystidia in *V. volvacea* are cylindrical to clavate, usually with 1–2 internal septa and measure $40\text{--}190 \times 5\text{--}15 \mu\text{m}$ (data from the Spanish collections; Justo & Castro 2010), while in *V. dunensis* caulocystidia are predominantly clavate or utriform, have no internal septa, and measure $20\text{--}75 \times 10\text{--}25 \mu\text{m}$.

Vila et al. (1999), who compare *V. dunensis* with species of similar habitat, note that *V. arenaria* (Pat.) Singer, described from the Arabian Desert, has smaller basidiocarps (pileus $\leq 30 \text{ mm}$) and larger basidiospores ($12\text{--}15 \times 8\text{--}10 \mu\text{m}$) while *V. psammophila* Singer, described from Argentina, has smaller basidiocarps (pileus $\leq 45 \text{ mm}$), smaller basidiospores ($6.2\text{--}7.3 \times 4.5\text{--}5.5 \mu\text{m}$), and much narrower pleuro- and cheilocystidia ($\leq 17 \mu\text{m}$).

2. *Volvariella earlei* (Murrill) Shaffer, Mycologia 49: 550. 1957

FIG. 2

= *Volvariopsis earlei* Murrill, Mycologia 3: 282. 1911.

= *Volvaria earlei* (Murrill) Murrill, Mycologia 4: 332. 1912.

PILEUS 25–45 mm; hemispherical or conical when young, later plano-convex, slightly depressed at center in old specimens; surface glabrous or innately fibrillose, viscid at least in young specimens; white or ochraceous at center [Mu. 10YR 8/2–8/4]; margin translucently striate. LAMELLAE crowded, free, (broadly) ventricose, up to 6 mm broad; white when young, later pink, with white flocculose even edges. STIPE 30–50 \times 2–6 mm, cylindrical, with slightly broadened base (up to 10 mm); white with some ochraceous tints [Mu. 10YR 8/2–8/3]; glabrous or pruinose. VOLVA saccate, membranous, 2–4 lobed, glabrous, white, up to 20 mm high. CONTEXT white or with some yellowish tints. SMELL not recorded. TASTE not recorded. SPORE PRINT not recorded.

BASIDIOSPORES [90, 6, 3] $11\text{--}16 \times (7.5\text{--})8\text{--}11 \mu\text{m}$, avl \times avw = $13.4\text{--}14.6 \times$

9.1–9.7 Mm, $Q = (1.25\text{--})1.3\text{--}1.6(-1.7)$, $avQ = 1.45\text{--}1.55$ ellipsoid, more rarely broadly ellipsoid or oblong. BASIDIA $20\text{--}40 \times 8\text{--}16 \mu\text{m}$, 4-spored or 2-spored, rarely 1-spored, broadly clavate. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA $30\text{--}70 \times 10\text{--}35 \mu\text{m}$, clavate, fusiform, lageniform or conical, usually each cheilocystidium with a flexuous apical appendage up to $40 \mu\text{m}$ long; with thin, smooth walls; abundant, crowded. PILEIPELLIS an ixocutis made up of cylindrical hyphae, $5\text{--}15 \mu\text{m}$ wide, colorless; with thin, smooth walls; embedded in a gelatinous, colorless, matrix. STIPITPELLIS a cutis; hyphae $5\text{--}15 \mu\text{m}$ wide, cylindrical, colorless; with thin, smooth walls. CAULOCYSTIDIA (not always present) $65\text{--}140 \times 10\text{--}25 \mu\text{m}$, cylindrical, hyaline or with brown pigment, sometimes with 1(–2) internal septa; with thin, smooth walls; scattered. CLAMP CONNECTIONS absent in all tissues.

ECOLOGY AND DISTRIBUTION—In gardens, on soil. In Spain known from one locality (Madrid: Móstoles). June–July.

COLLECTIONS EXAMINED—SPAIN: Madrid: Móstoles, Coimbra Park, in garden, 7.VI.1986, F.D. Calonge, MA-Fungi 16324; idem, 7.VII.1987, MA-Fungi 19490; idem, 20.VII.1989, MA-Fungi 22816.

COMMENTS—*Volvariella earlei* is closely related to *V. gloiocephala* (DC.) Boekhout & Enderle, as both species have basidiospores over $12 \mu\text{m}$ long and a pileipellis as an ixocutis. However the two differ in several macro- and microscopical characters. *Volvariella gloiocephala* has medium-sized to relatively large basidiomes (pileus $50\text{--}150 \text{ mm}$), and has larger basidiospores (generally $13.0\text{--}16.5 \times 8.0\text{--}9.3 \mu\text{m}$, $avQ = (1.5\text{--})1.6\text{--}1.85$), common and more or less clavate to fusiform pleurocystidia, and cheilocystidia that are sometimes apically papillate but not commonly rostrate (data from the Spanish collections; Justo & Castro 2010). *Volvariella earlei* produces smaller basidiomes (pileus $25\text{--}45 \text{ mm}$) with broader basidiospores, pleurocystidia that are absent (in the Spanish collections) or very rare (in North American collections, Shaffer 1957), and cheilocystidia that are usually rostrate.

Volvariella earlei, which was originally described from Cuba (Murrill 1911), has been reported thus far from the U.S.A (Coker 1947), Mexico (Vázquez et al. 1989), Africa (Heinemann 1975), and Sardinia (Contu 2006). The Spanish and the Italian collections were collected during late spring and summer (June–August) in artificially irrigated gardens, which suggests that *V. earlei* is a tropical species alien to Europe, but more research is needed to establish this with certainty.

The collections of *V. earlei* at MA herbarium were deposited under the name *Volvariella media* (Schumach.) Singer, but as Kosonen (1993) and Contu (2006) noted, the application of *Agaricus medius* Schumach., the basionym, is difficult to establish. In the original description, Schumacher (1803) described a small, whitish species that grows in coniferous forests (*Abies*, *Pinus*) during

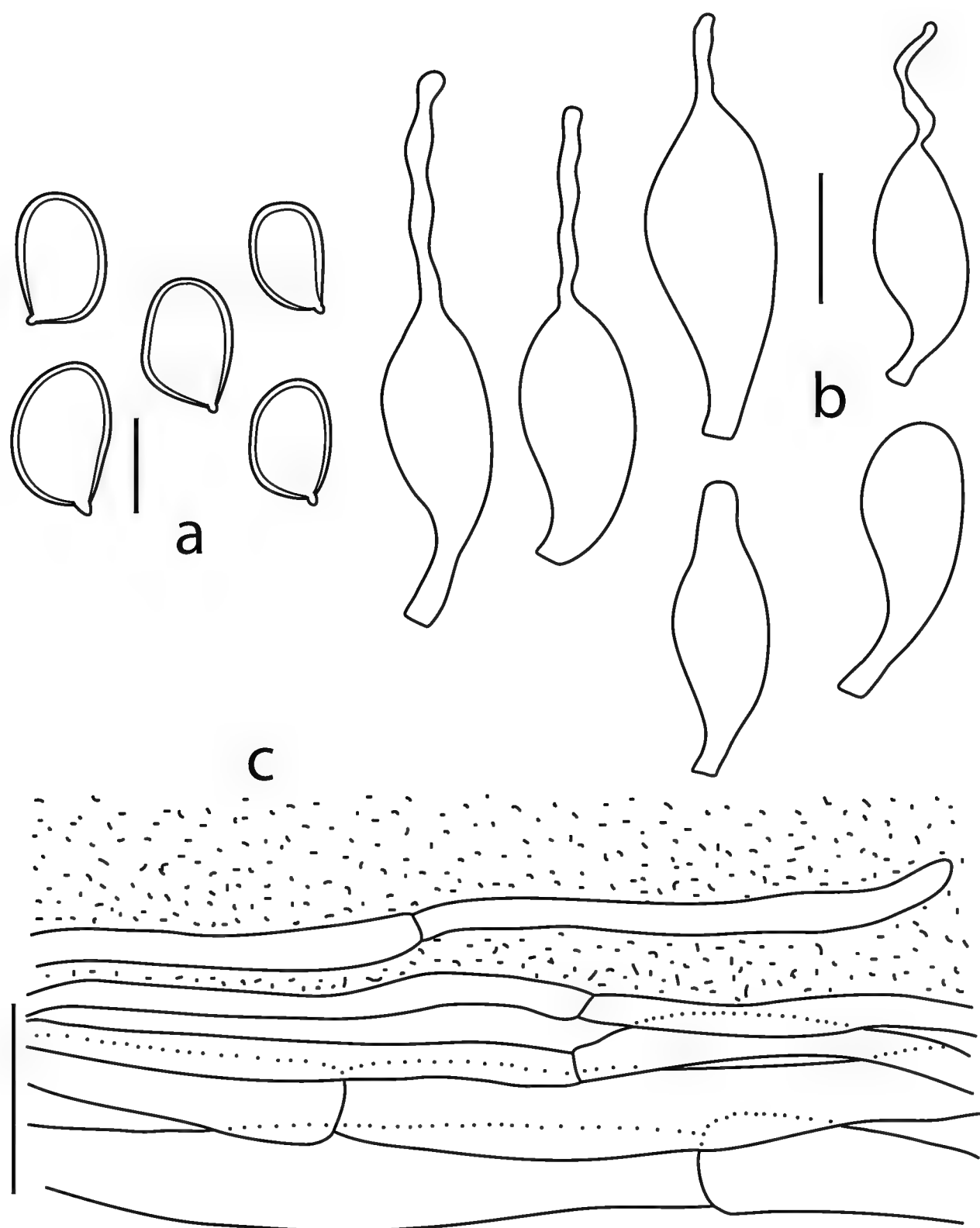


FIG 2. *Volvariella earlei*.
a = spores; b = cheilocystidia; c = pileipellis.
All from MA-Fungi 16324. Scale bars a = 10 μ m; b, c = 20 μ m.

the autumn (November) but provided no data on microscopic characters. Later authors have interpreted *Agaricus medius* in different ways: Bresadola (1929) described *Volvaria media* (Schumach.) Gillet, a nomenclatural synonym, as a small species with a gray, subtomentose volva and basidiospores of 7–9 \times

4–5 µm. Lange (1935) described a fungus that may correspond to *V. earlei* as described here based on its small basidiocarps, similar basidiospore size, and habitat on grassy fields, although some authors have argued that the species described by him is in fact just a small variant of *V. gloiocephala* (Contu 2006). Pilát (1959), who compared Bresadola's and Lange's different interpretations, proposed the name *Volvariella krizii* Pilát for the fungus described by Bresadola. Finally, Orton (1986) accounted for some British records that may represent *V. media* in the sense of Lange. In the Iberian bibliography there are three records under the names *Volvaria media* or *Volvariella media* (Torrend 1912, Rezende-Pinto 1943, Llimona et al. 1995). However none of them is provided with descriptions and/or cited herbarium collections. As we concur with Kosonen (1993) and Contu (2006) in considering *Agaricus medius* a doubtful name, we report the examined material as *V. earlei*.

Key to the species of *Volvariella* present in the Iberian Peninsula and Balearic Islands

- 1. Pileus viscid. Basidiospores > 12 µm long2
- 1. Pileus not or only slightly viscid. Basidiospores < 12 µm long3
- 2. Pileus 50–150 mm diam. Basidiospores with avQ = 1.6–1.85.
Pleurocystidia common. Cheilocystidia rarely rostrate *V. gloiocephala*
- 2. Pileus 25–45 mm diam. Basidiospores with avQ = 1.45–1.55.
Pleurocystidia absent or scarce. Cheilocystidia commonly rostrate *V. earlei*
- 3. Growing on wood4
- 3. Not on wood6
- 4. Pileus 30–100 mm diam., without distinct squamules. Pileipellis elements septate, up to 145(–200) µm long *V. caesiointincta*
- 4. Pileus 50–200 mm diam., covered with distinct fibrillose squamules. Pileipellis elements rarely septate, up to 1000–1600(–2000) µm long5
- 5. Pileus white, sometimes slightly yellowish in old specimens
.....*V. bombycina* var. *bombycina*
- 5. Pileus yellow from the beginning *V. bombycina* var. *flaviceps*
- 6. Growing on basidiocarps of *Clitocybe nebularis* *V. surrecta*
- 6. Habitat different7
- 7. Basidiospores with avw = 3.5–4 µm. avQ = 1.7–1.8*V. murinella*
- 7. Basidiospores with avw = 4.4–5.3 µm. avQ = 1.3–1.558
- 8. Pileus covered with radial grey or grey-brown fibrils (at least in the center)9
- 8. Pileus without radial grey or grey-brown fibrils11
- 9. Pleurocystidia and cheilocystidia clavate, obovoid or (narrowly) utriform, without elongated apices. Caulocystidia clavate, utriform, lageniform, flexuous, without internal septa. Volva white, fragile. In open dunes*V. dunensis*

9. Pleurocystidia and cheilocystidia fusiform, lageniform, clavate or utriform, commonly with elongated apices and/or apical appendages. Caulocystidia cylindrical, with internal septa. Volva grey-brown, not fragile. In grasslands in or outside forests or in places with abundant organic matter10
10. Pileus 30–50 mm diam. Volva glabrous, not covering more than the lower 1/3 of the stipe *V. taylorii*
10. Pileus 50–100 mm. Volva pubescent, usually covering more than the lower 1/3 of the stipe *V. volvacea*
11. Pileus up to 60 mm diam. Stipe pubescent even in old specimens *V. hypopithys*
11. Pileus up to 30 mm diam. Stipe glabrous in old specimens *V. pusilla*

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Literature cited

- Boekhout T. 1990. *Volvariella*. Pp 56–64, in C Bas, ThW Kuyper, ME Noordeloos, EC Vellinga (eds.). Flora Agaricina Neerlandica 2. Rotterdam, A.A. Balkema.
- Bresadola G. 1929. Iconographia Mycologica 11. Italy, Museo civico di storia naturale di Trento.
- Coker WC. 1947. North Carolina species of *Volvaria*. J. Elisha Mitchell Sci. Soc. 63: 220–230.
- Contu M. 2006. *Volvariella earlei* (Basidiomycota, Pluteaceae) nuova per l'Europa, e note sulla tassonomia di *Volvariella media* sensu J.Lange. Micol. Veg. Medit. 21(29): 101–106.
- Contu M, La Rocca S. 1999. Fungi Non Delinati IX: Fungi della zona insulare mediterranea italiana. Alassio, Ed. Candusso.
- Holmgren PK, Holmgren NH. 1998[continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/>.
- Kosina C. 1974. Nový druh kukmáku cernopochvý *Volvariella nigrovolvacea* Kosina sp. n. Cas. Ceskoslov. Houb. 5: 129–135.
- Kosonen L. 1993. Was ist *Volvariella media* (Schum. : Fr.) Sing.?. Zeitschrift für Mykologie 59 (1): 23–26.
- Heinemann P. 1975. Flore Illustrée des champignons d'Afrique centrale 4: *Volvariella*. Meise, National Botanical Garden of Belgium.
- Justo A, Castro ML. 2004. Familia *Pluteaceae* na micoteca LOU-Fungi: revisión nomenclatural e taxonómica. Mykes 7: 11–18.
- Justo A, Castro ML, Caballero A. 2005. Los géneros *Pluteus* y *Volvariella* (Basidiomycota, Fungi) en La Rioja (España). Rev. Catalana Micol. 27: 75–84.
- Justo A, Castro ML. 2010. An annotated checklist of *Volvariella* in the Iberian Peninsula and Balearic Islands. <http://www.mycotaxon.com/resources/weblists.html>. Summary: Mycotaxon 112: 271–273.
- Lange JE. 1935. Flora Agaricina Danica. Copenhagen, Recato.

- Llimona X, Vila J, Hoyo P, Aguasca M, Àngel F, Àngel E, Gràcia E, Llistosella J, Martín MP, Mayoral A, Rocabruna A, Sierra D, Tabarés M. 1995. El programa biodiversitat micològica de les terres de Ponent. Notícia i primers resultats. Rev. Catalana Micol. 18: 103–136.
- Murrill WA. 1911. The *Agaricaceae* of tropical North America. Mycologia. 3: 271–282.
- Munsell Color Company. 2000. Munsell Soil Color Charts. Revised washable edition. New Windsor, Gretag Macbeth.
- Orton PD. 1986. British Fungus Flora Agarics and Boleti 4: *Pluteaceae*: *Pluteus* and *Volvariella*. Edinburgh, Royal Botanic Garden.
- Pilat A. 1959. Kukmák prostředí - *Volvaria media* (Schumacher ex Fr.) Quél a *Volvaria media* ve smyslu Bresadolove. Ceska Mykol 13: 163–168.
- Rezende-Pinto MC. 1943. Hymeniales de Portugal. Brotéria, Sér. Ci. Nat. 12: 58–75.
- Schumacher, CF. 1803. Enumeratio Plantarum in partibus Saellandiae Septentrionalis et Orientalis. Havniae.
- Shaffer R. 1957. *Volvariella* in North America. Mycologia 49: 545–579.
- Torrend C. 1912. Les Basidiomycetes des environs de Lisbonne et de la région de S.Fiel (Beira Baixa). Brotéria, Sér. Bot. 10: 192–210.
- Vázquez LS, Guzmán-Dávalos L, Guzmán G. 1989. Contribution to the knowledge of the species of the genus *Volvariella* in the state of Jalisco. Rev. Mex. Micol. 5: 169–179.
- Vellinga EC. 1988. Glossary. Pp 54–64, in C Bas, ThW Kuyper, ME Noordeloos, EC Vellinga (eds.). Flora Agaricina Neerlandica 1. Rotterdam, A.A. Balkema.
- Vila J, Àngel F, Llimona X. 1999. *Volvariella nigrovolvacea* Kosina var. *dunensis* Vila, Àngel & Llimona var. nov. Rev. Catalana Micol. 22: 131–135.

An annotated checklist of *Volvariella* in the Iberian Peninsula and Balearic Islands

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Abstract — This checklist collates data on the 12 taxa of *Volvariella* reported from the Iberian Peninsula (Spain, Portugal) and Balearic Islands (Spain). The complete checklist, posted at <http://www.mycotaxon.com/resources/weblists.html>, provides data on the collections, distribution, ecology, and phenology of each taxon.

Key words — *Agaricales*, *Agaricomycetes*, biodiversity, *Pluteaceae*

Introduction

Volvariella Speg. is a genus traditionally classified in the family *Pluteaceae* Kotl. & Pouzar (*Agaricales*, *Basidiomycota*), but recent molecular research has challenged its monophyly and taxonomic position within the *Agaricales* (Moncalvo et al. 2002, Matheny et al. 2006). Its main characteristics are the pluteoid basidiomes (i.e., free lamellae; context of pileus and stipe discontinuous), universal veil present in mature specimens as a saccate volva at the stipe base, brownish-pink spores in mass, and — primarily — inverse lamellar trama. *Volvariella* comprises about 50 species (Kirk & al. 2008) and is widely distributed around the world (Singer 1986).

Monographic studies of the genus have been mostly carried out in Europe (Kühner & Romagnesi 1956; Orton 1974, 1986; Boekhout 1990), North America (Shaffer 1957), and Africa (Heinemann 1975, Pegler 1977).

In the Iberian Peninsula (Spain, Portugal) and Balearic Islands (Spain) the records of *Volvariella* are scattered, as they are often included in general checklists. Prior to our study, the only taxonomic paper on this genus in this region was an article by Vila et al. (1999), which described the new taxon, *Volvariella nigrovolvacea* var. *dunensis*. Justo & Castro (2004 and Justo et al.

(2005) published studies on *Volvariella* within the Iberian Peninsula as a part of the Flora Mycologica Iberica project. Here, we present the first comprehensive account of *Volvariella* in the Iberian Peninsula and Balearic Islands.

Collections examined

We have studied the collections gathered by members of the Mycology Lab at Vigo University from 1991 to 2008. Collections of *Volvariella* deposited in several Iberian herbaria, both official and personal, have been examined and revised.

The information obtained from the bibliographic references of *Volvariella* in the Iberian literature has been incorporated into the distribution maps for each species.

Catalogue

In the online checklist (<http://www.mycotaxon.com/resources/weblists.html>) the following information is given for each taxon: a list of all collections examined; a map of its distribution in our area and some brief comments on its ecology and phenology.

The catalogue covers the following 12 taxa of *Volvariella* recorded in the Iberian Peninsula and Balearic Islands:

1. *Volvariella bombycina* (Schaeff.) Singer var. *bombycina*
2. *Volvariella bombycina* var. *flaviceps* (Murrill) Shaffer
3. *Volvariella caesiotincta* P.D. Orton
4. *Volvariella dunensis* (Vila et al.) Justo & M.L. Castro
5. *Volvariella earlei* (Murrill) Shaffer
6. *Volvariella gloiocephala* (DC.) Boekhout & Enderle
7. *Volvariella hypopithys* (Fr.) Shaffer
8. *Volvariella murinella* (Quél.) M.M. Moser ex Dennis et al.
9. *Volvariella pusilla* (Pers.) Singer
10. *Volvariella surrecta* (Knapp.) Singer
11. *Volvariella taylorii* (Berk. & Broome) Singer
12. *Volvariella volvacea* (Bull.) Singer

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Felipe Wartchow and Andrew M. Minnis are thanked for their very helpful comments on the presubmission reviews. This work is included in the project Flora Mycologica Iberica VI (CGL2006-12732-C02-01/BOS).

Literature cited

- Boekhout T. 1990. *Volvariella*. Pp 56–64, in C Bas, ThW Kuyper, ME Noordeloos, EC Vellinga (eds.). Flora Agaricina Neerlandica 2. Rotterdam, A.A. Balkema.
- Justo A, Castro ML. 2004. Familia *Pluteaceae* na micoteca LOU-Fungi: revisión nomenclatural e taxonómica. *Mykes* 7: 11–18.
- Justo A, Castro ML, Caballero A. 2005. Los géneros *Pluteus* y *Volvariella* (*Basidiomycota*, *Fungi*) en La Rioja (España). *Rev. Catalana Micol.* 27: 75–84.
- Heinemann P. 1975. Flore Illustrée des champignons d'Afrique centrale 4: *Volvariella*. Meise, National Botanical Garden of Belgium.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Ainsworth & Bisby's dictionary of the fungi. 10th edition. Wallingford, CAB International.
- Kühner R, Romagnesi H. 1956. Espèces nouvelles, critiques ou rares de Volvariacees. *Bull. Trimestiel Soc. Mycol. France* 72: 181–249.
- Matheny PB, Curtis JM, Hofstetter V, Aime MC, Moncalvo JM, Ge Z-W, Yang Z-L, Slot JC, Ammirati JF, Baroni TJ, Bougher NL, Hughes KW, Lodge DJ, Kerrigan RW, Seidl MT, Aanen DK, DeNitis M, Daniele GM, Desjardin DE, Kropp BR, Norvell LL, Parker A, Vellinga EC, Vilgalys R, Hibbett DS. 2006. Major clades of *Agaricales*: a multilocus phylogenetic overview. *Mycologia* 98: 982–995.
- Moncalvo JM, Vilgalys R, Redhead SA, Johnson JE, James TY, Aime MC, Hofstetter V, Verduin SJW, Larsson E, Baroni TJ, Thorn RG, Jacobsson S, Cléménçon H, Miller Jr OK. 2002. One hundred and seventeen clades of eugagarics. *Mol. Phylogenet. Evol.* 23: 357–400.
- Orton PD. 1974. The European species of *Volvariella*. *Bull. Soc. Linn. Lyon num. special* 43: 313–326.
- Orton PD. 1986. British Fungus Flora. Agarics and Boleti. 4: *Pluteaceae: Pluteus* and *Volvariella*. Edinburgh, Royal Botanic Garden.
- Pegler DN. 1977. A preliminary agaric flora of East Africa. *Kew Bull. Add. Ser VI*. Kew, Royal Botanic Gardens.
- Shaffer R. 1957. *Volvariella* in North America. *Mycologia* 49: 545–579.
- Singer R. 1986. The *Agaricales* in modern taxonomy (4th edition). Koenigstein, Koeltz Scientific Books.
- Vila J, Àngel F, Llimona X. 1999. *Volvariella nigrovolvacea* Kosina var. *dunensis* Vila, Àngel & Llimona var. nov. *Rev. Catalana Micol.* 22: 131–135.

The first record of *Parmotrema pseudocrinitum* (*Parmeliaceae*, lichenized *Ascomycota*) in South America

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Abstract — *Parmotrema pseudocrinitum* is reported for the first time in South America, from northern Argentina. A description of this species and comparisons with related species are presented. A key to species of *Parmotrema* with ciliate isidia and maps of their distribution are included.

Key words — lichens, protected areas, *Parmotrema crinitum*, *Parmotrema mellissii*, *Parmotrema melanochaetum*

Introduction

Parmeliaceae is one of the largest families of lichen-forming fungi and has been the subject of much recent research, particularly studies to establish phylogenetic relationships among the parmelioid taxa based on both morphological and molecular data (Crespo et al. 1999, 2001; Divakar et al. 2005, Louwhoff & Crisp 2000, Molina et al. 2004).

Parmotrema A. Massal. is one of the larger genera in the *Parmeliaceae* with approximately 350 species and a center of distribution in the world's tropical regions. As circumscribed by Blanco et al. (2005) based on recent molecular studies, the genus is characterized by an upper cortex of palisade plectenchyma or paraplectenchyma with vaults, a pored epicortex, the lack of pseudocyphellae, the presence or absence of cilia, laminal perforate or imperforate apothecia, ellipsoid ascospores, and filiform, cylindrical, bacilliform or sublageniform conidia.

As a result of research aimed at studying the species diversity of lichenized and non-lichenized fungi in protected areas in northern Argentina, *P. pseudocrinitum* was found for the first time in South America.

Materials and methods

The specimens studied were collected recently by the authors in two National Parks in northern Argentina and are preserved in CTES (Instituto de Botánica del Nordeste Herbarium).

The morphological analysis is based on observations of macroscopic and microscopic characters with stereoscopic and optical microscopes (Leica MZ6 and Olympus BX 50 respectively). Apothecia and pycnidia were cut by hand with a razor blade and then mounted in 5% KOH to study the ascospores and conidia. Measurements were made with objectives at 400 and 1000× magnification.

Chemical substances were identified using spot tests with 10% KOH (K), sodium hypochlorite (C), and K followed by C (KC), UV fluorescence, and Thin Layer Chromatography (TLC). TLC was carried out using solvents A and C according to the methodology proposed by Culberson (1972), Culberson & Kristinsson (1970), Culberson & Ammann (1979), and White & James (1985).

The distribution maps (FIGS. E–G) are based on records found in the literature (Calvelo & Liberatore 2002, Chen et al. 2005, Elix 1994, Elix & Gremmen 2002, Eliasaro & Donha 2003, Jungbluth 2006, Hale 1965, 1976; Hale & Kurokawa 1965, Krog 1974, Krog & Swinscow 1981, Kurokawa & Lai 2001, Louwhoff & Elix 1998, 2002; Marcelli & Ribeiro 2002, Nagaoka & Marcelli 1989, Nash & Elix 2002, Osorio 1992, 1994; Osorio & Fleig 1988, 1990; Sipman et al. 2008).

Taxonomy

Key to *Parmotrema* species with ciliate isidia

- 1a. Medulla K–2
- 1b. Medulla K+ persistently yellow (stictic acid present) or yellow turning red
 (salazinic acid present)6
- 2a. Isidia frequently becoming sorediate; medulla UV+ bright blue-green, KC+ orange
 (alectoronic acid present) *P. mellissii*
- 2b. Isidia rarely or not becoming sorediate; medulla UV–, KC– or KC+3
- 3a. Medulla P+ red (protocetraric acid present)*P. subcorallinum*
- 3b. Medulla P– (protocetraric acid absent)4
- 4a. Medulla C+ salmon pink, KC+ reddish (olivetric acid present) *P. horridum*
- 4b. Medulla C+ rose, KC+ rose (gyrophoric acid present)5
- 5a. Upper surface strongly to rather distinctly maculate; rhizines simple
 *P. melanochaetum*
- 5b. Upper surface emaculate to rarely slightly maculate; rhizines simple to
 irregularly branched..... *P. pseudocrinitum*
- 6a. Medulla K+ yellow turning red (salazinic acid present)7
- 6b. Medulla K+ persistently yellow (stictic acid present)8
- 7a. Medulla UV+ yellow (liquexanthone present)*P. ultralucens*
- 7b. Medulla UV– (liquexanthone absent)*P. neosubcrinitum*
- 8a. Medulla uniformly white, yellow-orange pigment absent.....*P. crinitum*
- 8b. Medulla mostly white, yellow-orange pigment (euplectin) present
 near lower surface.....*P. ochrocrinitum*

Parmotrema pseudocrinitum (Abbeyes) Hale, Phytologia 28(4): 338 (1974)

≡ *Parmelia pseudocrinita* Abbeyes, Bull. Inst. Fr. Afr. Noire, Sér. A, 20: 19 (1958)

THALLUS foliose, mineral grey to grey green, corticolous, loosely to moderately attached to substrate, 4–15 cm in diameter; lobes rounded, (3–)5–10 mm wide, contiguous to partially imbricate, margin crenate, densely ciliate; cilia simple, occasionally furcate, (0.2–)0.4–1.3(–2) mm long, mostly present in the incisions of the margin, ascending. UPPER SURFACE smooth, rugose in some areas in the center of the thallus, rarely fissurate, emaculate to rarely slightly maculate, densely ciliate. ISIDIA laminal to occasionally marginal or submarginal, simple to coralloid, frequently with simple cilia, 0.2–1 mm long, or brown-tipped. SORALIA absent. PUSTULAE absent. MEDULLA white; K+ purple pigment absent. LOWER SURFACE black, smooth to rugose, shiny, moderate to densely rhizinate, with a narrow, brown erhizinate marginal zone, smooth to rugose; rhizines black, long, generally simple, sometimes furcate. APOTHECIA absent or present, sparse, (0.6–)1.5–6 mm wide, thalline exciple moderately to densely isidiate, the isidia frequently ciliate, simple or branched; disc imperforate, pale to dark brown, epruinose, ±rugose; mature ascospores not seen. PYCNIDIA rarely present, sparse, submarginal; conidia filiform, (6.6–)7–9.3(–13.28) μm .

CHEMISTRY — Cortex K+ yellow, UV– (atranorin); medulla K–, C+ rose, KC+ rose, UV– (gyrophoric acid).

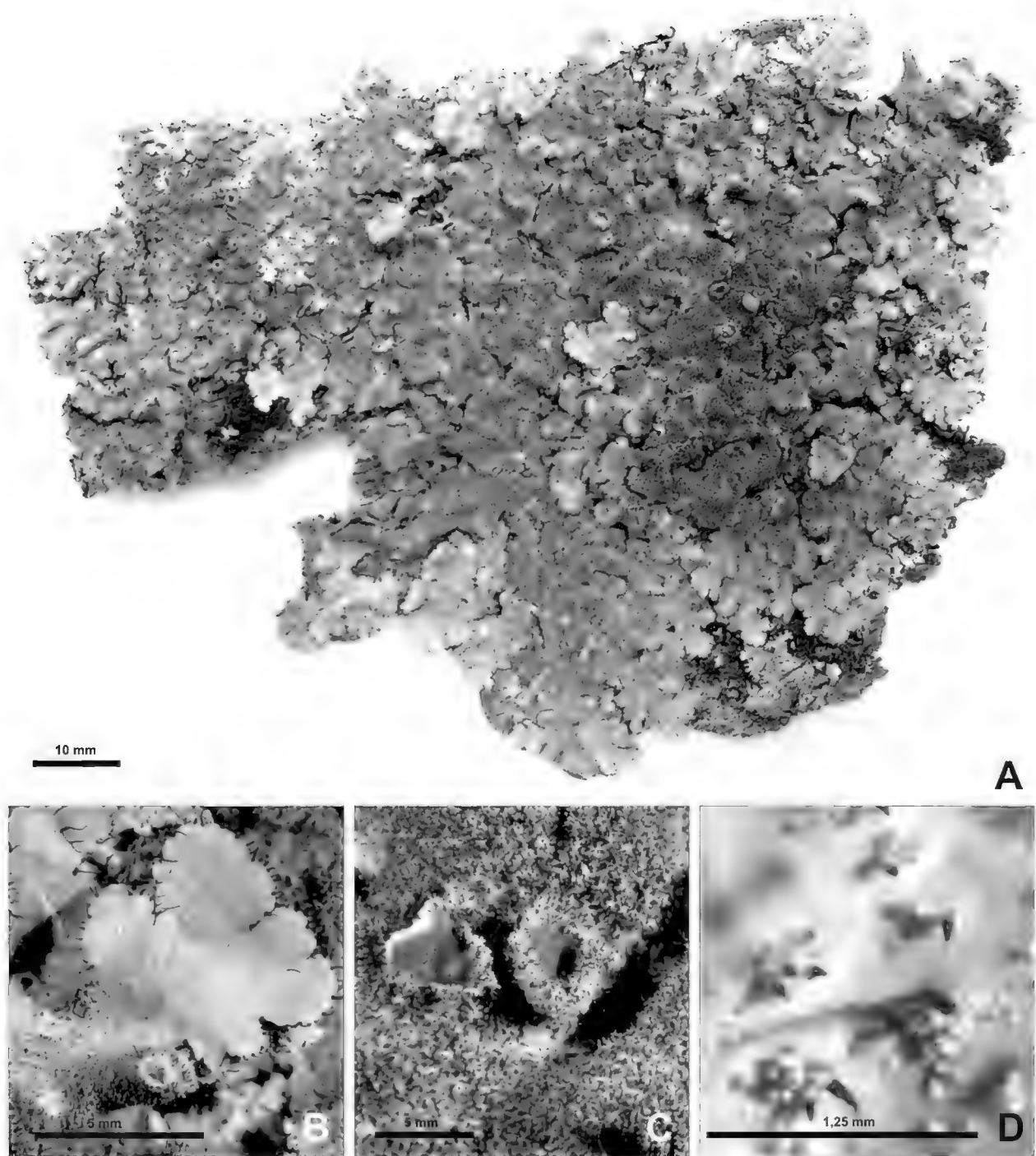
SPECIMENS_EXAMINED — ARGENTINA. Corrientes Province, Depto. Mburucuyá, Mburucuyá National Park, Estancia Santa Teresa, on *Enterolobium contortisiliquum*, 28/II/07, Michlig, Niveiro & Meza Torres 311 (CTES); Estancia Santa Teresa, in front of the historical center, on *Tabebuia heptaphylla*, 20/VII/2006, Ferraro et al. 8088 (CTES), Estancia Santa Teresa, near the historical center, 28° 01' S, 58° 01' W. Ferraro et al. 8094 (CTES), idem., 8101 (CTES). Misiones Province, Depto. Iguazú, Iguazú National Park, Camping site Ñandú, 28/IV/2004, Ferraro & Popoff 7426 (CTES).

DISTRIBUTION — *Parmotrema pseudocrinitum*, previously known from Africa (Hale 1965, Krog & Swinscow 1981), was recently reported for the first time from the Neotropics by Boom et al. (2007), who recorded it for Guatemala (FIG. E). This is the first record of the species for South America.

Discussion

Parmotrema pseudocrinitum is characterized by the ciliate lobes, the simple or branched, often ciliate isidia (FIGS. A,B,D), the white medulla and the presence of atranorin and gyrophoric acid as principal chemical substances. Boom et al. (2007) also mention the presence of minor quantities of lecanoric acid in the medulla.

Hale (1965) noted that the medulla in this species could have K+ purple pigmented areas near the lower surface, but in the material we examined, the medulla is completely white and no K+ purple pigment is present.



FIGS. A–D. *P. pseudocrinitum*. A: Complete thallus (scale bar = 10 mm). B: Lobes margins (scale bar = 5 mm). C: Apothecia with imperforate disc (scale bar = 5 mm). D: Ciliate isidia (scale bar = 0.6 mm).

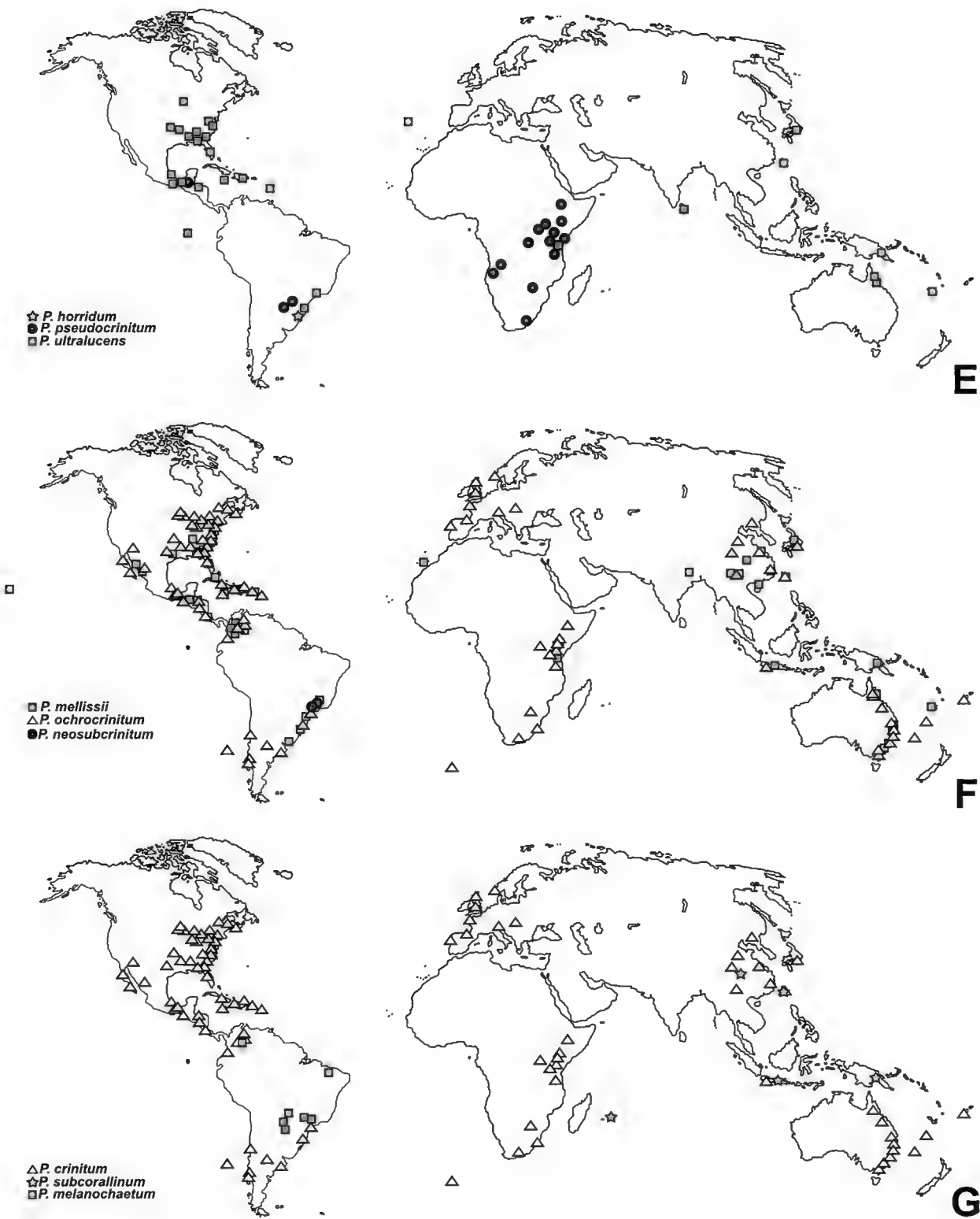
Apothecia with imperforate disc were present in many of the specimens studied (FIG. c) but as the ascospores were immature, their characteristics were not reported here. According to Krog & Swinscow (1981), the disc may become perforate and the ascospores measure $15\text{--}18 \times 6\text{--}8(-10) \mu\text{m}$. Pycnidia were only found in one specimen (Ferraro 8094). The observed conidia were slightly shorter than reported by Krog & Swinscow (1981) [(6.6–)7–9.3(–13.3) versus 10–12 μm long]. All Argentinean specimens were found on bark, but Krog & Swinscow (1981) mentioned that this species may also occur on rock.

Parmotrema pseudocrinitum is morphologically similar to the cosmopolitan species *P. crinitum* (Ach.) M. Choisy and *P. mellissii* (C.W. Dodge) Hale (FIGS. F–G), characterized by the presence of ciliate lobes and isidia, but they are easily differentiated by their respective medullary chemistries. *Parmotrema crinitum* is clearly distinguished by stictic acid, which shows a persistent K+ yellow reaction. The ascospore size and conidial size and shape also differ. According to Elix (1994), the conidia of *P. crinitum* are sublageniform and 3–4 µm long, while those in *P. pseudocrinitum* are filiform and (6.6–)7–9.3(–13.28) µm long. The ascospores of *P. crinitum*, which are larger than those in *P. pseudocrinitum*, are 25–35 × 12–18 µm (Elix 1994, Krog & Swinscow 1981).

Parmotrema mellissii can be distinguished from *P. pseudocrinitum* by the presence of coralloid isidia that eventually become sorediate and the presence of alectoronic acid in the medulla (KC+ light orange and UV+ bright blue-green). Krog & Swinscow (1981) and Elix (1994) observed that the medulla in *P. mellissii* could have areas with an ochraceous K+ purple pigment (skyrin), the same reaction that was cited by Hale (1965) for *P. pseudocrinitum*. In *P. mellissii* apothecia are rarely found, the disc is imperforate, and the ascospores measure 10–14 × 16–22 µm (Hale 1965, Elix 1994); furthermore, pycnidia are not commonly found (Elix 1994, Krog & Swinscow 1981, Nash & Elix 2002). Eliasaro & Donha (2003) describe the conidia as filiform and 7–10 µm long, thus similar to those found in *P. pseudocrinitum*.

Parmotrema ochrocrinitum Elix & J. Johnst., *P. subcorallinum* (Hale) Hale, *P. horridum* Fleig, *P. ultralucens* (Krog) Hale, and *P. neosubcrinitum* C.H. Ribeiro & Marcelli are also characterized by the presence of ciliate isidia. *Parmotrema ochrocrinitum* and *P. subcorallinum* both resemble *P. crinitum*. The first is endemic to Australia (FIG. F) and can be distinguished by the presence of a yellow-orange pigment (euplectin) in the lower medulla (Elix & Johnston 1988). *Parmotrema subcorallinum*, a scattered species known mainly in southeast Asia (FIG. G), differs in producing protocetraric acid rather than stictic acid (Kurokawa & Lai 2001, Chen et al. 2005). *Parmotrema ultralucens* is a cosmopolitan species (FIG. E) distinguished by the presence of atranorin in the cortex and lichexanthone and salazinic acid in the medulla (Krog 1974). *Parmotrema neosubcrinitum*, known only from Brazil (FIG. F), resembles *P. ultralucens* but differs in the medullar chemistry (Marcelli & Ribeiro 2002). *Parmotrema horridum*, a Brazilian endemic (FIG. E), resembles *P. mellissii* but differs in containing olivetoric acid in the medulla (Fleig 1999).

Parmotrema melanochaetum (Kurok.) O. Blanco et al. is a South American species (FIG. G) characterized by the presence of ciliate isidia and gyrophoric acid in the medulla, similar to *P. pseudocrinitum*. According to Hale & Kurokawa (1965) and Hale (1976) the upper cortex is strongly to rather distinctly white maculate and the rhizines are simple, which differs on the material found in



FIGS. E–G. Maps showing the world distribution of *P. pseudocrinitum* and related species.
E: *P. horridum*, *P. pseudocrinitum*, and *P. ultralucens*.
F: *P. mellissii*, *P. ochrocrinitum*, and *P. neosubcrinitum*.
G: *P. crinitum*, *P. subcorallinum*, and *P. melanochaetum*.

Argentina. In the specimens studied, Only one specimen studied has a slightly maculate upper cortex and the rhizines are simple to irregularly branched. Due to these differences, we identify our material as *P. pseudocrinitum*. Nonetheless, a thorough revision of the types of these species is needed.

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Literature cited

- Blanco O, Crespo A, Divakar PK, Elix JA, Lumbsch HT. 2005. Molecular phylogeny of parmotremaoid lichens (*Ascomycota*, *Parmeliaceae*). *Mycologia* 97(1): 150–159.
- Boom PPG van den, Elix JA, Sipman HJM. 2007. New or interesting lichen records from Guatemala I. *Willdenowia* 37: 363–375.
- Calvelo S, Liberatore S. 2002. Catálogo de los líquenes de la Argentina. *Kurtziana* 29 (2): 7–170.
- Chen JB, Wang SL, Elix JA. 2005. *Parmeliaceae* (*Ascomycota*) lichens in China's mainland III. The genus *Parmotrema*. *Mycotaxon* 91: 93–113.
- Crespo A, Blanco O, Hawksworth DL. 2001. The potential of mitochondrial DNA for establishing phylogeny and stabilising generic concept in the parmelioid lichens. *Taxon* 50(3): 807–919.
- Crespo A, Gavilán R, Elix JA, Gutiérrez G. 1999. A comparison of morphological, chemical and molecular characters in some parmelioid genera. *Lichenologist* 31(5): 451–460.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized Thin–Layer Chromatographic method. *J. Chromatogr.* 72: 113–125.
- Culberson CF, Ammann K. 1979. Standardmethode zur Dünnschicht–Chromatographie von Flechtensubstanzen. *Herzogia* 5: 1–24.
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr.* 46: 85–93.
- Divakar PK, Blanco O, Hawksworth DL, Crespo A. 2005. Molecular phylogenetic studies on the *Parmotrema reticulatum* (syn. *Rimelia reticulata*) complex, including the confirmation of *P. pseudoreticulatum* as a distinct species. *Lichenologist* 37(1): 55–65.
- Eliasaro S, Donha C. 2003. The genera *Canomaculina* and *Parmotrema* (*Parmeliaceae*, lichenized *Ascomycota*) in Curitiba, Paraná State, Brazil. *Revista Brasil. Bot.*, 26(2): 239–247.
- Elix JA. 1994. *Parmotrema*. *Flora of Australia* 55: 140–162.
- Elix JA, Gremmen NJM. 2002. The lichen family *Parmeliaceae* (*Ascomycotina*) on Gough Island, South Atlantic Ocean. *Mycotaxon* 81: 257–264.
- Elix JA, Johnston J. 1988. New species in the lichen family *Parmeliaceae* (*Ascomycotina*) from the Southern Hemisphere. *Mycotaxon* 31(2): 491–510.
- Fleig M. 1999. New species in the lichen genus *Parmotrema* (*Parmeliaceae* *Ascomycotina*) from Southern Brazil. *Mycotaxon* 71: 199–206.
- Hale ME. 1965. A Monograph of the *Parmelia* subgenus *Amphigymnia*. *Contr. U. S. Natl. Herb.* 36(5): 193–358.
- Hale ME. 1976. A Monograph of the lichen genus *Parmelina* Hale (*Parmeliaceae*). *Smithsonian Contr. Bot.* 33: 1–60.
- Hale ME, Kurokawa S. 1965. Studies on *Parmelia* subgenus *Parmelia*. *Smithsonian Contr. Bot.* 36(4): 121–191.
- Jungbluth P. 2006. A família *Parmeliaceae* (fungos liquenizados) em fragmentos de cerrados do Estado de São Paulo. Mastership dissertation, Instituto de Botânica, São Paulo, 313 p.
- Krog H. 1974. *Parmelia ultralucens*, a new lichen species in the subgenus *Amphigymnia*. *Bryologist* 77(2): 253–256.

- Krog H, Swinscow TDV. 1981. *Parmelia* subgenus *Amphigymnia* (lichens) in East Africa. Bull. Brit. Mus. (Nat. Hist.), Bot. 9(3): 143–231.
- Kurokawa S, Lai MJ. 2001. Parmelioid lichen genera and species in Taiwan. Mycotaxon 77: 225–284.
- Louwhoff SHJJ, Crisp MD. 2000. Phylogenetic analysis of *Parmotrema* (*Parmeliaceae*: Lichenized *Ascomycotina*). Bryologist 103(3): 541–554.
- Louwhoff SHJJ, Elix JA. 1998. The lichen family *Parmeliaceae* (*Ascomycotina*) on Lord Howe Island, Australia. Mycotaxon 68: 429–463.
- Louwhoff SHJJ, Elix JA. 2002. The *Parmeliaceae* (lichenized *Ascomycota*) of New Caledonia. Lichenologist 35(5): 373–394.
- Marcelli MP, Ribeiro CH. 2002. Twenty-one New species of *Parmeliaceae* (lichenized fungi) from southeastern Brazil. Mitt. Inst. Allg. Bot. Hamburg 30–32: 125–155.
- Molina MC, Crespo A, Blanco O, Lumbsch HT, Hawksworth DL. 2004. Phylogenetic relationships and species concepts in *Parmelia* s. str. (*Parmeliaceae*) inferred from nuclear ITS rDNA and β -tubulin sequences. Lichenologist 36(1): 37–54.
- Nagaoka LY, Marcelli MP. 1989. Líquenes da Área de Reserva do Parque Estadual das Fontes do Ipiranga. Acta Bot. Brasil. 3(2): 95–98.
- Nash III TH, Elix JA. 2002. *Parmotrema*. Pp. 318–329 in: TH Nash III, BD Ryan, C Gries, F Bungartz (eds.). Lichen Flora of the Greater Sonoran Desert Region. Arizona State University, Vol. 1.
- Osorio HS. 1992. Contribución a la Flora Liquéncia del Uruguay. XXV. Líquenes publicados entre 1972 a 1991. Anales Mus. Nac. Montevideo. ser.2, vol. 1: 47–70.
- Osorio HS. 1994. Contribution to the lichen flora of Brazil. XXX. Additional records from the municipality of Canela, Rio Grande do Sul. Mycotaxon 51: 175–177.
- Osorio HS, Fleig M. 1988. Contribution to the lichen flora of Brazil. XX. Comun. Bot. Mus. Hist. Nat. Montevideo 85(5): 1–7.
- Osorio HS, Fleig M. 1990. Contribution to the lichen flora of Brazil. XXIV. Lichens from Nova Petropolis, Rio Grande Do Sul State. Mycotaxon 36(2): 325–327.
- Sipman HJM, Hekking W, Aguirre-C J. 2008. Checklist of lichenized and lichenicolous fungi from Colombia. Bibl. J. J. Triana 20. Instituto de Ciencias Naturales, Facultad de Ciencias, Universidad Nacional de Colombia. 242 pp.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of the lichen substances. Bull. Brit. Lichen Soc. 57: 1–41.

On the infraspecific variability and taxonomic position of *Entoloma zuccherellii*

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Abstract — A recent find of the enigmatic and extremely rare fungus *Entoloma zuccherellii* in the Czech Republic has given more insight in the infraspecific variation of that species. A detailed description of this find and comparison with Italian and Spanish finds are provided. The taxonomic and phylogenetic position of *E. zuccherellii* is discussed.

Key words — *Entolomataceae*, *Rhodocybe*, Czech Republic, spores

Introduction

In 2007 and 2008, the first author carried out a mycological research of Central Bohemia, a region around Prague, Czech Republic (Holec 2009). In 2007, special attention was focused on Kokořínsko Protected Landscape Area, a sandstone region 40 km NNE of Prague. In the Kokořínský důl Nature Reserve, an interesting lignicolous fungus resembling a small *Entoloma* species with a bluish-brown stipe was found. The first author was unable to identify it using the newest *Entoloma* monograph (Noordeloos 2004). A revision done by the second author showed that it was conspecific with *Rhodocybe zuccherellii* (Noordeloos & Hausknecht 2000), recently transferred to the genus *Entoloma* (Co-David et al. 2009). Records of this species are rare, and it was known previously only from the type locality in Italy and a second collection from Spain (Vila & Caballero 2009). Therefore the Czech find is published here in detail.

Material and methods

The first author microscopically examined material mounted in a 5% KOH solution using an Olympus BH-2 microscope, except for pileus and stipe

cuticle pigments, which were observed in pure water. Spore measurements were determined from 20 randomly selected mature, fully developed spores. Microcharacters were drawn at a magnification of $1250\times$ using a drawing tube. Descriptive terminology follows Bas et al. (1988). Colour terms are English translations of the original field description written in Czech. For colour codes see Kornerup & Wanscher (1981). The collection studied is kept in the herbarium PRM (National Museum, Mycological Department, Prague, Czech Republic). Abbreviations: L = number of lamellae reaching up to the stipe, l = number of lamellulae between each pair of two lamellae, Q = quotient of length and width of the spores, Qav = mean value of Q in the collection studied.

Taxonomy

Entoloma zuccherellii (Noordel. & Hauskn.) Co-David & Noordel.,

Persoonia 23: 175, 2009.

PLATES 1–3

= *Rhodocybe zuccherellii* Noordel. & Hauskn., Bollettino del

Gruppo Micologico G. Bresadola, n.s. 43(3): 29, 2000.

MACROCHARACTERS (based on 3 basidiocarps found; 1 young, 2 mature) — **PILEUS** 4–10 mm, hemispherical with inflexed margin and flattened upper part, mat, slightly hygrophanous, margin indistinctly translucently striate, whole surface scarcely and finely white fibrillose-pruinose, dark brown when young and moist (5F4-6), then dark brown at centre and brown (5E5-6) to ochre-brown (5D6-7) towards margin, margin remaining dark brown when moist; **LAMELLAE** sparse, L = 13–20, l = 1–3, segmentiform, adnate when young, then emarginate, greyish brown-beige (4C3-4) when young, then pale yellowish beige (3A-B3), with concolorous, eroded edge; **STIPE** 7–15 \times 1.5–2.5 mm, cylindrical or slightly broadened towards base, ground colour dark grey-brown (6F2-3) to grey-brown (6E3-4) with a slight steel blue tinge, whitish pruinose when young, then whitish fibrillose to finely fibrillose-scaly at apex, base whitish tomentose; **TASTE** and **SMELL** not recorded.

MICROCHARACTERS — **BASIDIOSPORES** (5.6)6.0–7.6(8.0) \times (5.2)5.6–6.4(6.8) μm , average size 6.9 \times 6.0 μm , Q = 1.06–1.29, Qav = 1.16, variable in size and shape, general shape subglobose to almost globose, rarely broadly ellipsoid, many-angled when fully mature, angles indistinct, usually with one big oil droplet, wall slightly thickened, large number of immature or poorly developed spores present (without angles, of deviating shape, without content, such spores were not measured); **BASIDIA** 27–32 \times 7.0–9.5 μm , larger on lamellae edge, up to 37 \times 10 μm , 4-spored, narrowly clavate to clavate, with slight median constriction, content granular; **BASIDIOLES** 16–27 \times 7–8 μm , narrowly clavate to clavate, hyaline; **LAMELLAE EDGE** fertile, rarely with protruding clavate cells which are slightly larger than basidia, about 40 \times 9–15 μm , with granular



PLATE 1. *Entoloma zuccherellii*, Czech Republic, Kokořinský důl Nat. Reserve (PRM 909361).
Photo J. Holec. Colour photo: <http://www.nm.cz/english/departments/mycology-gallery.php>

content; LAMELLAR TRAMA regular, cells long and cylindrical or shorter and slightly inflated, 4–22 μm broad, hyaline, wall with yellow membrane pigment; PILEIPELLIS a cutis of densely arranged parallel hyphae 4–15(19) μm broad, made up of long and cylindrical or shorter and fusiform to barrel-shaped elements (sometimes with a median constriction), terminal elements 12–20 μm broad, barrel-shaped, clavate, rarely with a mucronate projection, the cuticle is pale brown in mass, elements are hyaline („empty“) with pale yellow membrane pigment as well as a rather pale, granulose intracellular pigment, pileocystidia absent; STIPITPELLIS a cutis of densely arranged parallel hyphae 4–16 μm broad, made up of cylindrical to narrowly fusiform elements, with yellow membrane pigment and fine yellow-brown incrustations when observed in pure water, the cuticle is scarcely covered with narrow (5–7 μm) outgrowths or ascending terminal parts of narrower hyphae of the cutis, caulocystidia absent; CLAMP CONNECTIONS absent in all tissues.

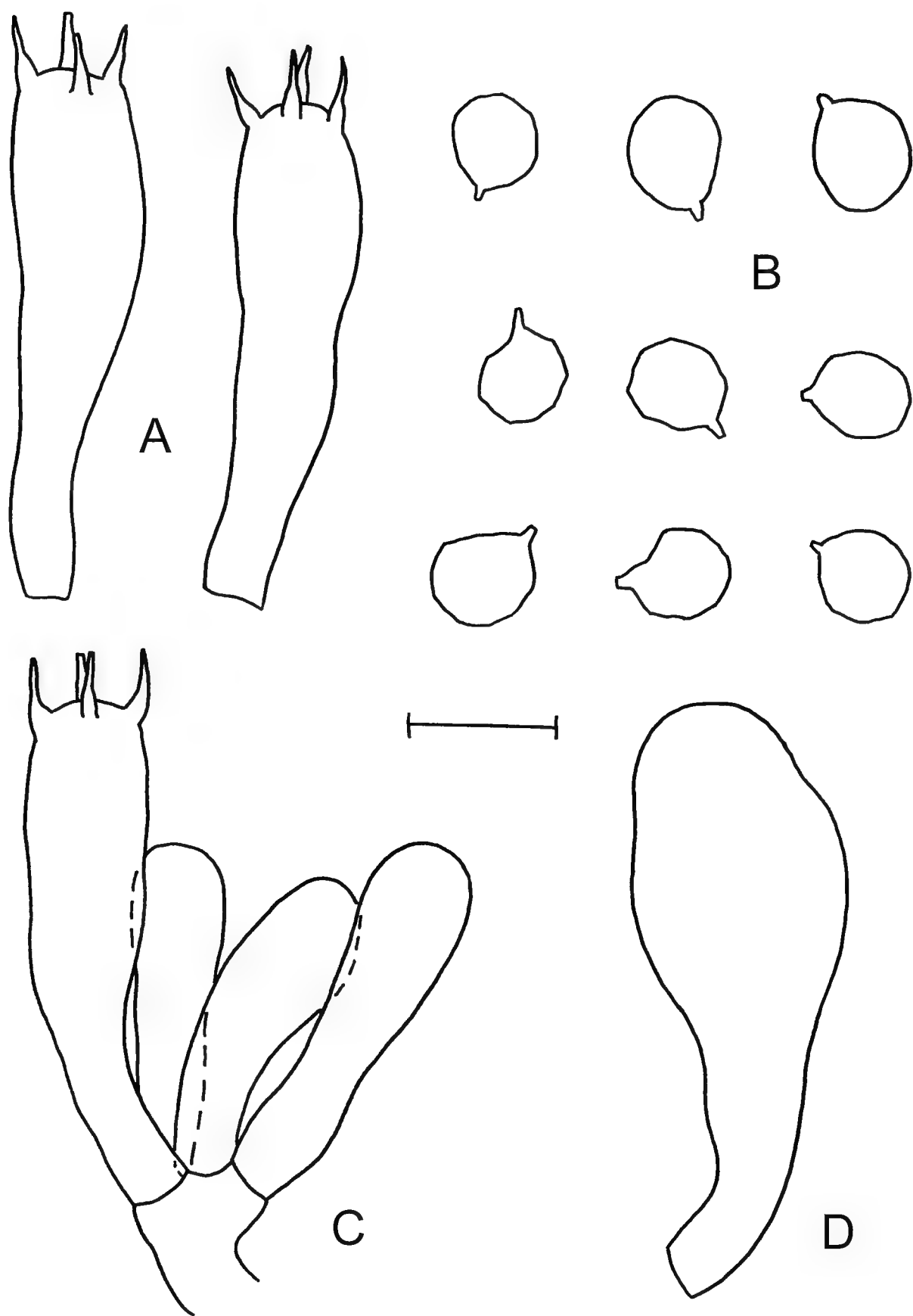


PLATE 2. *Entoloma zuccherellii*, microcharacters (PRM 909361).
A: basidia, B: basidiospores, C: basidium and basidiolae,
D: protruding clavate cell on lamella edge.
Bar = 10 μ m. Drawing by J. Holec.

MATERIAL STUDIED — CZECH REPUBLIC. CENTRAL BOHEMIA, Kokořínsko Protected Landscape Area, ca. 1 km NEE of the village of Kokořín near the town of Mšeno, KOKOŘÍNSKÝ DŮL NATURE RESERVE: trail along Pšovka stream, alt. 250 m, man-influenced mixed forest on E slope among sandstone rocks (*Fagus sylvatica*, *Picea abies*, *Quercus* sp., *Pinus sylvestris*), on decaying coniferous wood (*Picea*?), 19.X.2007 leg. T. Zíbar, det. M.E. Noordeloos (PRM 909361).

Discussion

The Czech collection is in good agreement with the type of *Entoloma zuccherellii* (Noordeloos & Hausknecht 2000) from Italy (Ravenna, Pineta di Classe), both in general appearance and in diagnostic characters such as the lignicolous habit, bluish tinges in the stipe, and (in particular) the small, weakly angled spores. The Czech material deviates slightly in the following characters: lamellae without violet tinge, emarginate at maturity; stipe with less distinct blue or violet tinge; spores slightly larger and slightly more prolonged (in holotype they measure $6.0\text{--}6.5 \times 5.5\text{--}6.0 \mu\text{m}$, $Q = 1.0\text{--}1.2$; $Q_{\text{av}} = 1.1$); lamellar edges with scattered protruding clavate cells that do not, however, represent true cheilocystidia; and pileus cuticle of wider hyphae. However, the differences are subtle and seem to demonstrate infraspecific variability.

The collection described from Spain (Vila & Caballero 2009) possesses the most distinct blue-violet tinge among the three collections discussed. The blue-violet tinge is very distinct on the stipe and readily visible even on the pileus surface. However, intraspecific variability with regard to the expression of blue and/or violaceous tinges is a well-known phenomenon within *Entoloma*. Similar species (e.g., *Entoloma vinaceum* (Scop.) Arnolds & Noordel. and the closely related North American species *E. trachyosporum* Largent) have varieties based on the presence or absence of blue-violaceous tinges (Arnolds & Noordeloos 1980, Largent 1994, Noordeloos 2004). The photograph published by Vila & Caballero (2009: fig. 8) shows young and fresh basidiocarps where the blue-violet pigments are very pronounced. In other characters the Spanish collections are very similar to the Czech one (including the presence of cells resembling cheilocystidia).

Concerning the ecology, two records are from the coniferous wood (Italy: *Pinus*, Czech Republic: *Picea*?) and one is from the wood of *Alnus glutinosa* (Spain).

Based on all three collections, *E. zuccherellii* can be characterised as follows: small fungus (pileus up to 17 mm), pileus violet-grey (when fresh and young) or grey- to dark brown with a white pruinose-fibrillose surface, lamellae with bluish or violet tinges when young, stipe tinged blue-violet (stable characters seen in all published collections) with a white fibrillose surface, spores measuring $5.6\text{--}7.0(8.0) \times 5.2\text{--}6.4(6.8) \mu\text{m}$ ($Q = 1.0\text{--}1.3$, $Q_{\text{av}} = 1.13$) and globose to subglobose and indistinctly angular, distinct cheilocystidia

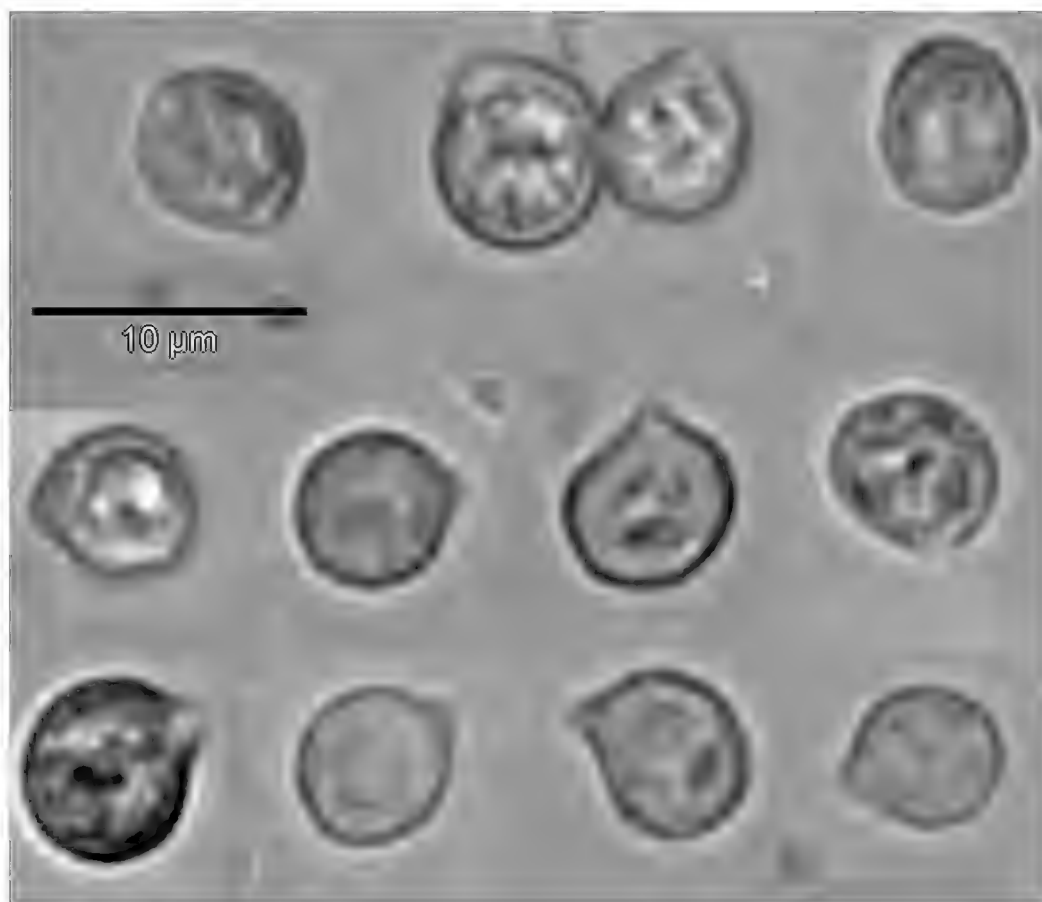


PLATE 3. *Entoloma zuccherellii*, variability of basidiospore shape (PRM 909361).
Bar = 10 µm. Photo by M.E. Noordeloos.

absent, lacking clamp connections, and growing on wood of coniferous and broadleaved trees.

Entoloma pluteisimilis Noordel. & C.E. Hermos., which is microscopically very similar, differs mainly by the lack of blue or violaceous tinges in the basidiocarps. Both *E. zuccherellii* and *E. pluteisimilis* have small, very thin-walled, many-angled spores that resemble those of *Rhodocybe* when observed in the light microscope, which was the main reason that *E. zuccherellii* was published as a new species in *Rhodocybe* (Noordeloos & Hausknecht 2000). SEM studies by Dorien Langeveld (MSc student in Leiden), however, showed that within *Entoloma* a whole gradient can be found from the well-known relatively thick-walled and distinctly angular spores to the thin-walled spores with complete and incomplete facets as well as bumps, similar to those found in true *Rhodocybe* species (Co-David et al. 2009). *Entoloma zuccherellii* and *E. pluteisimilis* both have spores at the bottom end of this range with irregular rugulose surfaces and a few indistinct ribs.

The three-gene molecular phylogeny by Co-David et al. (2009) placed both species in a monophyletic clade within *Entoloma* and distant from *Rhodocybe*, supporting their transfer of *R. zuccherellii* to *Entoloma*. The description of *Entoloma lignicola* Largent, which shares similar small, thin-walled spores and

a lignicolous habit (Largent 1989), suggests that it also belongs in the same clade.

Acknowledgements

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Literature cited

- Arnolds EJM, Noordeloos ME. 1980. New, rare and interesting species of *Entoloma*. *Fungorum rariorum icones coloratae*. Vol. 12. Vaduz, J. Cramer.
- Bas C, Kuyper TW, Noordeloos ME, Vellinga EC (eds). 1988. *Flora agaricina neerlandica*. Vol. 1. Rotterdam/Brookfield, A.A. Balkema.
- Co-David D, Langeveld D, Noordeloos ME. 2009. Molecular phylogeny and spore evolution of *Entolomataceae*. *Persoonia* 23: 147–176.
- Holec J. 2009. Red-listed macrofungi in Central Bohemia (Czech Republic), with taxonomic notes on *Entoloma mougeotii*, *Lentinellus ursinus* and *Pluteus phlebophorus*. *Journal of the National Museum (Prague), Natural History Series* 177(11): 145–159.
- Kornerup A, Wanscher JH. 1981. *Taschenlexikon der Farben*. Ed. 3. Zürich, Muster-Schmidt Verlag.
- Largent DL. 1989. A new, lignicolous species of *Entoloma* (*Entolomataceae*, *Agaricales*) from California. *Mycotaxon* 34: 129–131.
- Largent DL. 1994. *Entolomatoid fungi of the Pacific Northwest and Alaska*. USA, Mad. River Press: Eureka.
- Noordeloos ME. 2004. *Entoloma* s.l. Supplemento. *Fungi Europaei*, vol. 5A. Alassio SV, Edizioni Candusso.
- Noordeloos ME, Hausknecht A. 2000. Tre nuove *Entolomataceae* (*Agaricales*) dall'Italia. *Bollettino del Gruppo Micologico G. Bresadola*, n.s. 43(3): 23–33.
- Vila J, Caballero F. 2009. *Entoloma* nuevos o interesantes de la Península Ibérica (2). *Fungi non Delineati* 45: 1–100.

Contribution to the study of gasteroid and secotioid fungi of Chihuahua, Mexico

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Abstract — Including the twenty-seven new records reported herein, fifty-seven taxa of gasteroid fungi are now known from Chihuahua. *Geastrum schmidelii* var. *parvisporum* represents a new record for the Mexican mycobiota. A nom. nov. is proposed for *Agaricus texensis*, which is an illegitimate later homonym. The species presented are annotated with observations on macro- and microscopic characters, and SEM photomicrographs illustrating spore and capillitial characters are included for selected taxa.

Key words — *Agaricomycetes*, *Gasteromycetes* sensu lato, chorology, taxonomy

Introduction

Chihuahua, the largest state in Mexico, is located in the north and bordered by the Mexican states of Sonora to the west, Durango to the south, and Coahuila to the east and by the U.S. states of Texas and New Mexico to the north. The predominant vegetation types found in the state are coniferous forest, oak forest, grassland, xerophytic scrub, and tropical deciduous forest (Rzedowsky 1978). Prior to this study, thirty-one gasteroid taxa had previously been reported from Chihuahua. Initial records for the state are contained in the publications that follow.

Guzmán & Herrera (1973): *Arachnion album* Schwein., *Battarreoides diguetii*, *Bovista pusilla* (Batsch) Pers., *Cyathus montagnei* Tul. & C. Tul., *Lycoperdon*

marginatum (as *L. candidum*), *Melanogaster umbrinogleba* Trappe & Guzmán, *Phallus impudicus* L., *Pisolithus arhizus* (as *P. tinctorius*), and *Scleroderma cepa*.

Pérez-Silva & Aguirre-Acosta (1986): *Agaricus aridicola* Geml et al. (as *Gyrophragmium dunalii*), *Calvatia cyathiformis* (Bosc) Morgan, *C. gigantea* (Batsch) Lloyd, *Crucibulum laeve* (as *C. vulgare*), *Cyathus olla* (Batsch) Pers., *Lycoperdon echinatum* Pers., *L. perlatum*, *L. umbrinum* Pers., *Melanogaster nauseosus* Coker & Couch, *Scleroderma verrucosum*, *Simblum texense* (G.F. Atk. & Long) Long, and *Tulostoma wrightii* Berk.

Laferrière & Gilbertson (1992): *Astraeus hygrometricus*, *Cyathus stercoreus*, *Disciseda hyalothrix* (as *D. pedicellata*), *Gastrum saccatum*, *G. triplex*, *Lycoperdon oblongisporum* Berk. & M.A. Curtis, *L. pyriforme*, and *Mycenastrum corium*.

Moreno-Fuentes et al. (1994): *Lycoperdon peckii* Morgan.

Quiñónez-Martínez et al. (1999): *Scleroderma areolatum*.

Materials and methods

Material for study was primarily collected by students of the Universidad Autónoma de Ciudad Juárez; however, one of us (ML) contributed several collections. The specimens are deposited in the Herbarium of the “Departamento de Ciencias Básicas, Universidad Autónoma de Ciudad Juárez” (cited here as UACJ; Mexico) and the Herbarium of the “Departamento de Biología Vegetal, Universidad de Alcalá, Madrid” (AH; Spain)

Microscopic characters (e.g., spore dimension, which includes ornamentation) were observed under the light microscope (Nikon Eclipse 80i) on material mounted in Hoyer’s medium. Ultrastructural studies (e.g., spore ornamentation details) under the scanning electron microscope (SEM) were conducted on the specimens housed in Spain (AH). Samples were prepared according to the critical-point-drying method outlined in Moreno et al. (1995) and examined on a Zeiss DSM-950. Detailed descriptions, for the most part, are given only for species that represent new records for the state of Chihuahua.

Taxonomy

***Agaricus deserticola* G. Moreno, Esqueda & Lizárraga nom. nov.**

MYCOBANK MB 516712

- ≡ *Secotium texense* Berk. & M.A. Curtis, Grevillea 2: 34 (1873)
- ≡ *Gyrophragmium texense* (Berk. & M.A. Curtis) Massee, Grevillea 19: 96 (1891)
- ≡ *Longia texensis* (Berk. & M.A. Curtis) Zeller, Mycologia 35: 414 (1943)
- ≡ *Longula texensis* (Berk. & M.A. Curtis) Zeller, Mycologia 37: 636 (1945)
- ≡ *Agaricus texensis* (Berk. & M.A. Curtis) Geml, Geiser & Royse, Mycol. Progr. 3: 172 (2004), nom. illegit., non *A. texensis* Berk. & M.A. Curtis (1853)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, NUEVO RELLENO SANITARIO, leg. R. Rivas, 2.VI.1996, *UACJ* 1128 in *AH* 38925. SAMALAYUCA, growing on sandy soil, leg. A. Gatica, 1.IV.2000, *UACJ* 1129. PARQUE EL CHAMIZAL, growing on soil, leg. H.A. Peña, 13.III.2001, *UACJ* 1134 in *AH* 38926. SAMALAYUCA, RANCHO ZORRO PLATEADO, growing on sandy soil, leg. F. García & F. Piñera, 20.IV.2003, *UACJ* 1127. Municipality of Ahumada, VILLA AHUMADA, RANCHO SANTA MÓNICA, growing on sandy soil among *Poaceae* grasses, leg. J. Piñera, A. Fernández, M. Méndez, R. Castellanos & F. García, 1.III.2003, *UACJ* 1132. Municipality of Chihuahua, RANCHO EL CAPRICHIO, associated with *Ephedra* sp., leg. F. García A. Rodríguez, E. Orozco & A. Fernández, 30.IV.2003, *UACJ* 1133. Municipality of Juárez, CIUDAD JUÁREZ, urban zone next to Instituto Tecnológico de Cd. Juárez, associated with *Washingtonia filifera* (Linden ex André) H. Wendl., leg. M. Lizárraga & S. Escobar, 15.V.2006, *UACJ* 1130.

OBSERVATIONS — This species is characterized by a broadly globose 7–12 cm tall basidiome with a 2–4 × 6.5–9 cm pileus, peridial remains that typically form a membranous double annulus, a striate 6.5–8 × 2–4 cm stalk that extends as a percurrent columella through the pileus, and which lacks a volva. The basidiospores are 6–8 × 5–6 µm, subglobose to ovoid, smooth, very dark, and lack a germ pore.

Macro- and micro-morphological studies have been made previously on Mexican material from Baja California (Ochoa & Moreno 2006) and Sonora (Moreno et al. 2007). Molecular phylogenetic analyses support this secotioid fungus in *Agaricus*, a genus previously restricted to agaricoid forms (Geml et al. 2004). This is the first report of this taxon from Chihuahua.

Astraeus hygrometricus (Pers.) Morgan, J. Cincinnati Soc. Nat. Hist. 12: 20 (1889)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ocampo, BASASEACHI, in pine-oak wood, leg. M. Lizárraga, 12.VIII.2001, *UACJ* 1146 in *AH* 37847.

OBSERVATIONS — A capillitium that is hyaline, septate and with clamp connections and spores that are globose, 8–12(–13) µm in diam., and with pronounced verrucae characterize *A. hygrometricus*. Molecular studies (Phosri et al. 2007) support several species within *Astraeus*.

These include *A. odoratus* Phosri, M.P. Martín & Watling (Phosri et al. 2004) and *A. asiaticus* Phosri et al. (Phosri et al. 2007), which have been described from Asia, as well as *A. pteridis* (Shear) Zeller (= *Geastrum hygrometricum* var. *giganteum* Lloyd) that has previously been reported from Mexico (Phosri et al. 2007). Although the true identity of *A. hygrometricus* is not fully resolved (see Phosri et al. 2007), macro- and microscopic characters of the Chihuahuan material agree with those previously described under *A. hygrometricus* from Baja California (Ochoa & Moreno 2006). Several previous reports of “*A. hygrometricus*” have been made from Chihuahua (Laferrière & Gilbertson 1992; Quiñónez-Martínez et al. 1999, 2005; Quiñónez-Martínez & Garza-Ocañas 2003).

Battarrea phalloides (Dicks.) Pers., Syn. Meth. Fung. (Göttingen) 1: 129 (1801)
= *Battarrea stevenii* (Libosch.) Fr., Syst. Mycol. 3: 7 (1829)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ascensión, EJIDO PANCHO VILLA, among litter under *Prosopis* sp., leg. A. Gatica, 14.V.2000, UACJ 1160. Municipality of Casas Grandes, CASAS GRANDES, leg. M. Andrew, 19.VIII.2001, UACJ 1147. Ibidem, 18.V.2002, UACJ 1148.

OBSERVATIONS — This species is characterized by a 20–42 cm tall basidiome with a spore sac that is $1-2 \times 4-8$ cm, subglobose-depressed and dehisces when mature by a circumscissile opening, a brown-ferruginous gleba, a $18-40 \times 1-2$ cm, woody, fibrous stipe, and a free, fragile, sac-shaped volva that measures up to 6×4 cm. Spores are $5-6 \times 4-6$ μ m, globose to subglobose, verruculose, ochraceous and elaters are 3.5–7 μ m in diam., very variable in length, spiralled, pale yellow, aseptate, and unbranched.

This species is highly variable in size and grows mainly in xerophytic areas. Macro- and microscopic characters agree with the description given by Moreno et al. (1995), which was based on collections from Baja California. This is the first report for this species from Chihuahua.

Battarreoides diguetii (Pat. & Har.) R. Heim & T. Herrera, An. Inst. Biol. Univ. Mex. 32: 30 (1962, “1961”)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ahumada, VILLA AHUMADA, RANCHO SANTA MÓNICA, on sandy soil next to *Larrea tridentata* Coville and *Opuntia* sp., leg. F. García, A. Fernández, M. Méndez, E. Orozco & A. Fernández, 1.III.2003, UACJ 1149. SIERRA PEÑASCOS, leg. M. Vargas & M. Astorga, 15.IV.2006, UACJ 1151. Municipality of Juárez, SAMALAYUCA, next to *Larrea tridentata*, leg. A. Gatica & J. Córdova, 24.V.2003, UACJ 1150.

OBSERVATIONS — This species is characterized by its 14–20 cm tall basidiome and spore sac that is $3-6 \times 2.5-4$ cm, subglobose-depressed, and dehisces at maturity through several pores all over the spore sac surface. Gleba brown-ferruginous. Stipe $13-19 \times 1-1.3$ cm, woody, fibrous. Volva up to 1.2×1 cm, sac-shaped, free, fragile. Spores 4–5 μ m, globose to subglobose, verruculose, ochraceous. Elaters 2–7 μ m in diam., length very variable, spiralled, pale yellow, aseptate and not branched.

A macro- and microscopical study of this monospecific genus including SEM photographs was made by Moreno et al. (1995). *Battarreoides diguetii* was previously reported for Chihuahua by Guzmán & Herrera (1973) and Pérez-Silva & Aguirre-Acosta (1986).

Bovista aestivalis (Bonord.) Demoulin, Beih. Sydowia 8: 143 (1979)

= *Lycoperdon aestivale* Bonord., Handb. Allgem. mykol.: 251 (1851)
= *Lycoperdon polymorphum* Vittad., Monograph Lyc.: 39 (1842),
nom. illegit., non *L. polymorphum* Scop. (1772)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Guachohi, CUSARARE, in pine-oak wood, leg. C. Mass & V. Manriquez, 12.VIII.2001, AH 37830. Municipality of Bocoyna, SAN JUANITO, next to *Pinus* sp., leg. M.C. Natividad, B. Marín & M. Ángeles, 11.VIII.2001, AH 37831. Municipality of Madera, PRESA LAS PEÑITAS, in pine wood, leg. J. Vargas & J.M. Muñoz, 22.VIII.2003, AH 37828. Municipality of Chihuahua, CUMBRES DE MÁJALCA, growing amid leafy debris under *Cupressus* sp. and *Quercus* sp., leg. M. Lizárraga, 15.XI.2003, AH 37829, AH 37832.

OBSERVATIONS — Macroscopically, this species is characterized by a granulose to spinulose exoperidium that sloughs off easily and a conspicuous mycelial cord that persists at the base. Microscopically, *B. aestivalis* exhibits a capillitium of the intermediate-type, having yellowish, straight (rarely undulate), fragile, thick-walled capillitial threads (4–6 µm in diam.) with numerous large (up to 1 µm in diam.) pits. The spores of *B. aestivalis* are smooth to verruculose (under LM) and globose (4–5 µm in diam.).

A study of this species including SEM micrographs was made by Ochoa & Moreno (2006) based on collections from Baja California. Molecular studies (Larsson & Jeppson 2008, Bates et al. 2009, Larsson et al. 2009) confirmed the identity of this species and its taxonomic position within the genus *Bovista* Pers. This is the first report of *B. aestivalis* from Chihuahua.

Bovista fusca Lév., Ann. Sci. Nat., Bot., Sér. 3, 5: 303 (1846)

FIGS. 1–3

= *Bovista ruizii* T. Herrera, Ann. Inst. Biol. Univ. Mexico 30: 35 (1960, “1959”)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Guachochi, CUSARARE, leg. F. Piñera & R. Castellanos, 10.IV.2003, in pine-oak wood, UACJ 1121 in AH 37837.

OBSERVATIONS — A single mature, globose (2.5 cm in diam.) basidiome was collected that exhibited an irregular, apical ostiole. Its exoperidium was absent, and the endoperidium was membranous, smooth, dark reddish-brown. Microscopically, the specimen exhibited reddish-brown capillitium of the *Bovista*-type with thick-walled (8–17 µm in diam.), highly branched capillitial threads with long tapering tips. The spores were ovoid to subglobose (4.5–5.5 × 3.5–4.5 µm), smooth to minutely ornamented (under LM), with hyaline, more-or-less truncate, pedicels (8–16.5 µm long). Under SEM the spores exhibited abundant, truncate verrucae that were variable in size, irregularly distributed, and occasionally joined apically to form short ridges.

The macro- and microscopic characters of our specimen agree with those given in the protologue of *Bovista ruizii* (Herrera 1960), a species described from Mexico that was later synonymized with *B. fusca* (Kreisel 1967). *Bovista fusca* is similar to *B. nigrescens* Pers., described from Europe and Asia; however that species has globose to subglobose spores (4.2–6 µm in diam.) and shorter (4–9 µm in length) pedicels (Kreisel 1967). Reports of *B. nigrescens* from Mexico

(Calonge et al. 2004) were later corrected to *B. fusca* (Calonge et al. 2005). This is the first report of *Bovista fusca* from Chihuahua.

Calvatia fragilis (Vittad.) Morgan, J. Cincinnati Soc. Nat. Hist. 12: 168 (1890)

FIGS. 4–6

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Janos, 4.3 KM TO SOUTHWEST OF RANCHO LA GARRAPATA WAY, SIERRA DE EN MEDIO, leg. M. Lizárraga, 1.X.2005, UACJ 1154 in AH 37840.

OBSERVATIONS — The single collection made consisted of weathered specimens with small subgleba as well as lilac toned endoperidia and glebal remnants. Microscopically, the specimens exhibited ochraceous-yellowish, septate, fragile capillitial threads (2–5 µm in diam.) with numerous small pores. The spores were ochraceous, globose (5–7 µm in diam.), and spinulose, with ornamentation consisting of irregular to coralloid-shaped spines. Under SEM, occasional short, thin ridges that join the spines at their bases can be observed.

The closely related *Calvatia cyathiformis* can be distinguished from *C. fragilis* by its well-developed cellular subgleba with violaceous tones. Detailed descriptions have been made of *C. fragilis* collections from nearby areas, such as Baja California (Ochoa & Moreno 2006) and Arizona, USA (Bates et al. 2009). Previous reports of *Calvatia cyathiformis* from Chihuahua exist (Pérez-Silva & Aguirre-Acosta 1986, Laferrière & Gilbertson 1992). Some authors synonymize these species; however, both are valid species. *Calvatia fragilis* is reported here for the first time for Chihuahua.

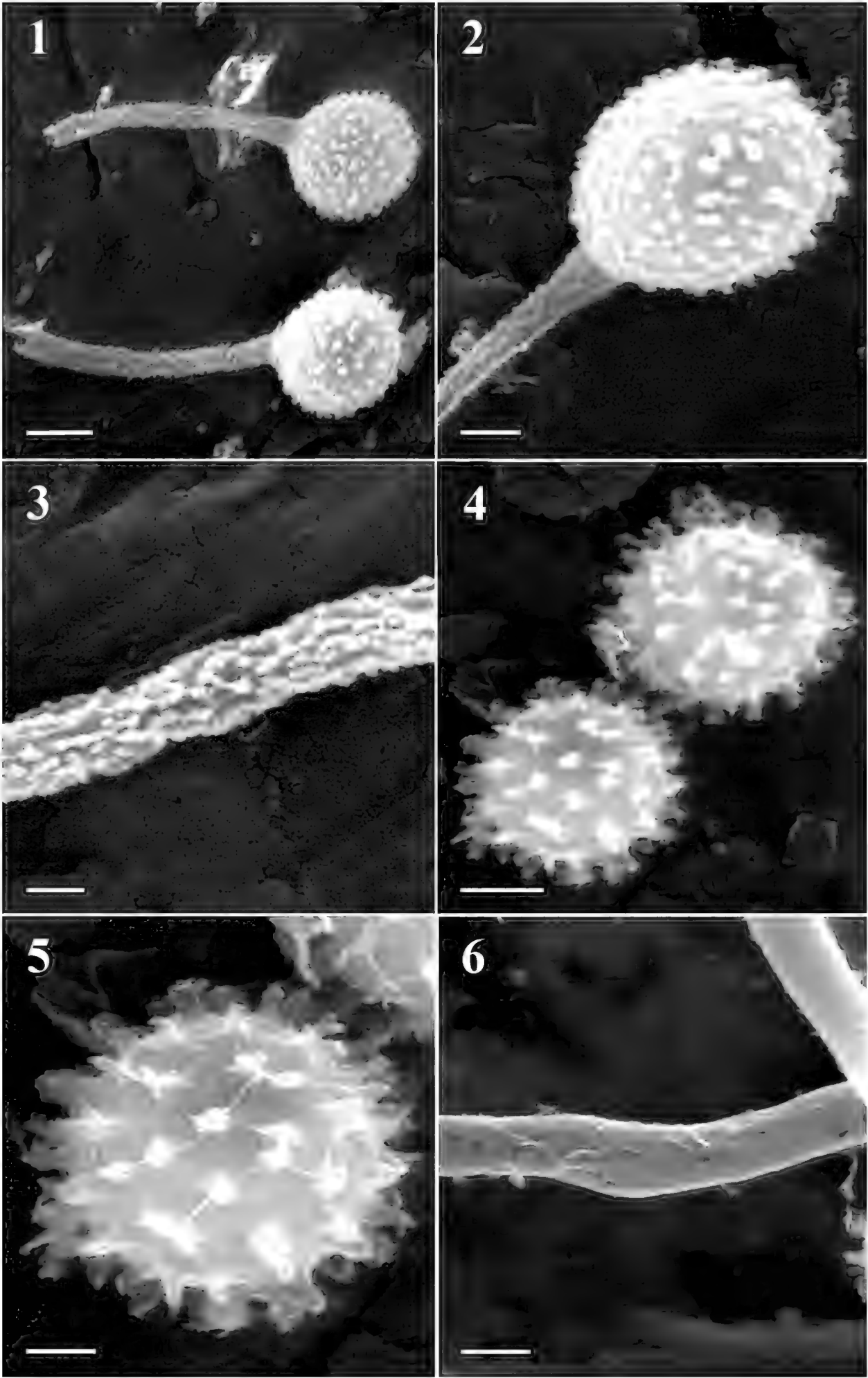
Crucibulum laeve (Huds.) Kambly, Gast. Iowa: 167 (1936)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Bocoyna, SAN JUANITO, on cow dung, leg. M. Vargas & M. Andrew, 11.VIII.2001, UACJ 1125. Municipality of Chihuahua, CUMBRES DE MAJALCA, on decayed wood of *Quercus* sp., leg. M. Lizárraga & G. Márquez, 15.XI.2003, UACJ 1124.

OBSERVATIONS — This species is clearly characterized by its sessile, cyathiform, 3–7 × 5–8 mm basidiome that, when young, is covered by an orange yellowish tomentum that is lost at maturity. Peridioles are numerous, lenticular, 3–6 × 1–2 mm, and whitish with a funiculus while basidiospores are 7–9 × 4–6 µm, ellipsoid, hyaline, and smooth.

This cosmopolitan species was previously cited from Chihuahua by Pérez-Silva & Aguirre-Acosta (1986), Laferrière & Gilbertson (1992), and Quiñónez-Martínez et al. (1999).

FIGS. 1–3: *Bovista fusca* AH 37837, 1. Spores. 2. Spore ornamentation detail. 3. Spore pedicel ornamentation detail. FIGS. 4–6: *Calvatia fragilis* AH 37840. 4. Spores. 5. Spore ornamentation detail. 6. Pitted capillitium. Scale bar 1, 4, 6 = 2 µm; 2, 5 = 1 µm; 3 = 0.5 µm.



Cyathus stercoreus (Schwein.) De Toni, Syll. Fung. (Abellini) 7: 40 (1888)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Bocoyna, SAN JUANITO, on cow dung, leg. M. Lizárraga, 11.VI.2001, UACJ 1123 in AH 37842.

OBSERVATIONS — Basidiomes abundant on dung, morphology variable, in general conical and with a basal zone or with a conspicuous pedicel; exoperidium hairy and shaggy when young but becoming smooth, yellowish brown to brown with age. Endoperidium smooth, dark gray. Peridiole black, 1.5–3 mm in diam., double-walled and without a tunica, with a whitish funiculus. Spores of 22–28(–30) × 18–25(–28) µm, globose to subglobose or broadly ellipsoid, subhyaline, thick-walled up to 3 µm.

Cyathus pictus H.J. Brodie, which has large spores similar to those of *C. stercoreus*, grows on decayed *Eucalyptus* wood. *Cyathus pictus* is known only from Mexico, while *C. stercoreus* has a worldwide distribution (Brodie 1975). Laferrière & Gilbertson (1992) and Quiñónez-Martínez et al. (1999) previously reported *C. stercoreus* from Chihuahua.

Disciseda candida (Schwein.) Lloyd, Mycol. Writ. 1: 100 (1902)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, KM 30 CIUDAD JUÁREZ TO CASAS GRANDES ROAD, next to *Prosopis glandulosa* Torr. and *Larrea tridentata*, leg. J. Carrasco, 20.X.2006, UACJ 1155 in AH 37815

OBSERVATIONS — One basidiome was studied: subglobose, endoperidium light gray, fibrillose ostiole, spores globose to subglobose, 4–5 µm in diam., asperate to verruculose. Capillitium 3–4 µm in diam., hyaline, yellowish, with septa and pores.

Ochoa & Moreno (2006) published a morphological study (including SEM photos of the ornamented spores) of this species based on collections from Baja California. This is the first report of *D. candida* for Chihuahua.

Disciseda hyalothrix (Cooke & Masee) Hollós, Növ. Közl. 1: 107 (1902)

= *Disciseda pedicellata* (Morgan) Hollós, Term. Füz. 25: 103 (1902)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, KM 10 TO SAN JERÓNIMO, on sandy and calcareous soil, leg. R. Martínez-Contreras, 23.III.2002, UACJ 1082 in AH 37816.

OBSERVATIONS — In Mexico, *D. hyalothrix* has previously been reported from arid zones in Baja California (Ochoa & Moreno 2006) and Sonora (Moreno et al. 2007). It is characterized by large, strongly ornamented spores [(6–) 7–8 µm in diam.] with episporial spines that are apically fused and form flat tipped processes that are easily observed under phase contrast microscopy or (more clearly) under SEM.

The spores consistently exhibit pedicels that vary in length as the fungus matures; however, climatic conditions may also play a role in the variation

observed. The Chihuahuan spores typically have pedicels that are approximately 2 µm long, although longer (≤ 4 µm) pedicels were also observed. Comparison of the type specimens of *Disciseda hyalothrix* and *D. pedicellata* by Moreno et al. (2003) concluded that these species are conspecific.

Laferrière & Gilbertson (1992) were the first to report *D. hyalothrix* from Chihuahua.

Disciseda verrucosa G. Cunn., Trans. & Proc. New Zealand Inst. 57: 205 (1926)

= *Disciseda arida* Velen., Novit. Mycol.: 169 (1939).

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, DUNAS DE SAMALAYUCA, on sandy soil, leg. A, Gatica, 31.III.2000, UACJ 1081 in AH 37822. Municipality of Janos, KM 100 JANOS TO AGUA PRIETA ROAD, next to *Acacia* sp., leg. M. Lizárraga, 17.VIII.2008, UACJ 1170 in AH 37821.

OBSERVATIONS — This species is clearly characterized by its 9–10 µm broad spores that are conspicuously ornamented with obtuse finger-like processes, typically curved at their apices (Pérez-Silva et al. 2000, Moreno et al. 2007).

This is the first report of *D. verrucosa* from Chihuahua. Bates et al. (2009) report this species from Arizona, but most North American records of are from Mexico (Sonora).

Geastrum fornicatum (Huds.) Hook., Curtis Fl. Londin. 4: 575 (1821)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, CIUDAD JUÁREZ TO CHIHUAHUA ROAD, under *Acacia* sp., leg. L.A. Rivera, 24.IV.2007, UACJ 1099 in AH 37857.

OBSERVATIONS — The single basidiome collected possessed four rays supporting the endoperidial body and lacked the exoperidial mycelial layer. The endoperidial body is globose with a narrowly conical, truncate, fibrillose peristome that is lighter than the endoperidium but not distinctly delimited. The spores are globose (4.5–5 µm in diam.) and ornamented with conspicuous verrucae.

Geastrum quadrifidum Pers. is another species with a fornicate gastrocarp; however, this species has a distinctly delimited peristome and larger spores (5.5–6.5 µm in diam.). *Geastrum leptospermum* G.F. Atk. & Coker is another closely related fornicate species that has smaller spores [(3–)3.5(–4) µm in diam.] that are less coarse than those of *G. fornicatum* (see Sunhede 1989). The also closely related *G. jurei* Lazo, described from a single basidiome collected in Chile, is differentiated by its non-delimited peristome that is noticeably lighter than the endoperidium (Lazo 1972). More new collections are needed to determine its taxonomic delimitation.

We report *G. fornicatum* from Chihuahua for the first time here.

Geastrum saccatum Fr., Syst. Mycol. 3: 16 (1829)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ocampo, BASASEACHIC, on litter in pine-oak wood, leg. C. Salazar & D. Mejia, 8.X.2004, UACJ 1103 in AH 37851. Municipality of Madera, PRESA PEÑITAS, on litter in pine-oak wood, leg. A. Santiesteban, M. León, J. Carrasco & L. Grimaldo, 15.IX.2007, UACJ 1161 in AH 37849 and UACJ 1107 in AH 37850.

OBSERVATIONS — This species is characterized by basidiomes with sessile, globose endoperidial bodies with fibrillose, distinctly delimited, occasionally recessed peristomes, non-hygroscopic rays, and 4–6 µm broad spores with pronounced verrucae.

Laferrière & Gilbertson (1992) previously reported *Geastrum saccatum* from Chihuahua.

Geastrum schmidelii* var. *parvisporum G. Moreno, Altés & Dios, Micologia

2000 (Trento), Ass. Micol. Bresadola: 159 (2000)

FIGS. 7–9

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Cusihuriachi, SAN BERNABÉ, amid leafy debris of *Quercus* sp. and *Cupressus* sp., leg. E. Orozco, 12.IV.2003, AH 37848.

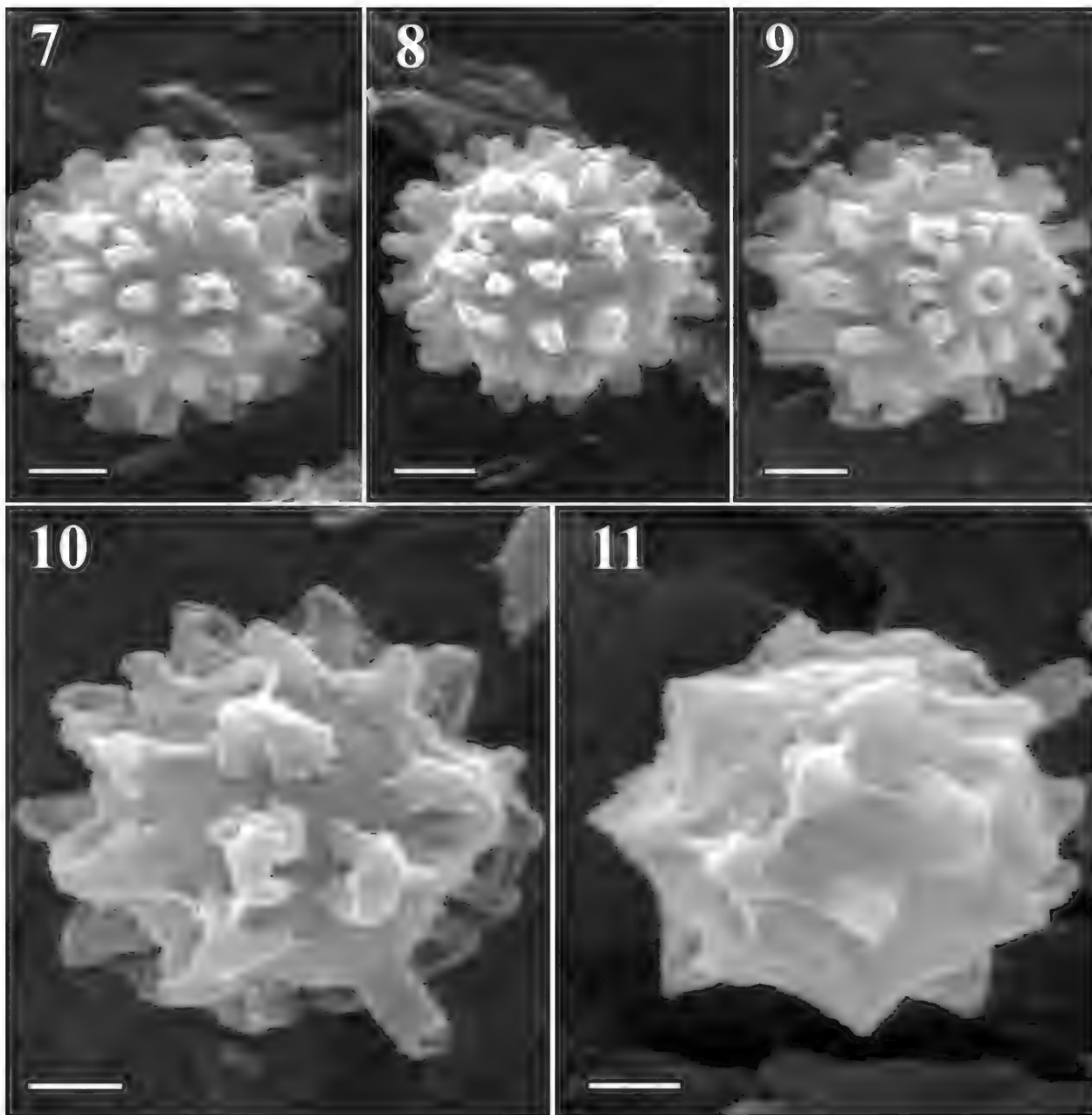
OBSERVATIONS — This species is characterized by non-hygroscopic rays, globose endoperidial bodies with short stalks that are covered with a fine pruinose layer, and recessed, plicate peristomes that are distinctly delimited by a rim. The 4.5–5(–5.5) µm broad spores possess dense, truncate verrucae.

The small spore size and other features observed in the Chihuahuan material agree with the description by Dios et al. (2000) of the same variety from Argentina (Dios et al. 2000). This taxon includes American material previously reported as *G. schmidelii* (Lloyd 1902, Coker & Couch 1928, Ponce de León 1946, Smith 1951) with spore dimensions that rarely exceed 5 µm in diam. However the spore dimensions cited for Arizonian material of *G. schmidelii* are (4.8–)5.6–6.4(–7.0) µm in diam., see Bates (2004). In contrast, European collections (*G. schmidelii* var. *schmidelii*) typically have larger spores [4.5–6.6 (–7) µm]. Under SEM, the spores exhibit long, slender, truncate verrucae, which are occasionally joined at their apices to form irregular-shaped ridges.

Geastrum schmidelii var. *parvisporum* is reported here for the first time from Mexico.

Geastrum triplex Jungh., Tijdschr. Nat. Gesch. Physiol. 7: 287 (1840)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Guachochi, CUSARARE, on litter of *Pinus* sp., leg. M. Lizárraga, 6.V.2000, UACJ 1100 in AH 37854. Municipality of Ocampo, BASASEACHIC, on litter of *Pinus* sp., leg. M. Lizárraga, 12.VIII.2001, UACJ 1098 in AH 37853. Ibidem, 8.X.2004, on leaf debris of *Quercus* sp., leg. E. Soto, N. Silva & M. Lizárraga, UACJ 1101 in AH 37856. Municipality of Bocoyna, SAN JUANITO, on litter in pine-oak wood, leg. C. Hernández-Ogaz, 15.IX.2006, UACJ 1174 in AH 37855.



FIGS. 7–9: *Geastrum schmidelii* var. *parvisporum* AH 37848. Spores. FIGS. 10–11: *Lycoperdon atropurpureum* AH 37811. Spores. Scale bar 7–11 = 1 μ m.

OBSERVATIONS — *Geastrum triplex* is characterized by its large size, non-hygroscopic rays, prominent pseudoparenchymatous collar, sessile endoperidial body that lacks an apophysis, and a distinctly delimited fibrillose peristome. Its 4–5 μ m broad basidiospores possess dense, truncate verrucae.

This species is commonly found in Mexico (Calonge et al. 2004), and it was first reported for Chihuahua by Laferrière & Gilbertson (1992).

Geastrum xerophilum Long, Mycologia 34: 13 (1942)

= *Geaster pluriosteum* Long & Stouffer, Mycologia 40: 553 (1948)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, KM 30 CIUDAD JUÁREZ TO CASAS GRANDES ROAD, in xerophytic area with *Larrea tridentata*, leg. J. Carrasco, 20.X.2006, UACJ 1106 in AH 37852.

OBSERVATIONS — Basidiomes of *G. xerophilum* have sessile, densely to minutely furfuraceous endoperidial bodies (1–2 cm in diam.) with short stipes, endoperidia that split into 6–7 rays (typically recurved at their tips and closely surrounding the endoperidial body at its base), a brownish gray gleba, and non-delimited, small, truncate, applanate to conical plicate peristomes that are concolorous with endoperidium. Microscopically, *G. xerophilum* exhibits glabrous, aseptate, unbranched capillitium (3–4 µm in diam.) that lack pores and globose, verrucose spores (4–5 µm in diam.) with dense, truncate verrucae.

This is the first report of *Geastrum xerophilum* from Chihuahua. It was previously reported in Mexico from the states of Morelos and Sonora (Pérez-Silva et al. 1999).

Lycoperdon atropurpureum Vittad., Monograph Lyc.: 42 (1842) FIGS. 10–11

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Bocoyna, SAN JUANITO, in pine wood, leg. H.A. Peña, 10.VIII.2001, UACJ 1152 in AH 37807. LAGO DE ARARECO, in pine-oak wood, leg. M. Andrew & M. Vargas, 11.VIII.2001, UACJ 1153 in AH 37808. Municipality of Guachochi, CUSARARE, in pine-oak wood, leg. C. Mass & V. Manriquez, 12.VIII.2001, UACJ 1173 in AH 37811. Municipality of Ocampo, BASASEACHIC, in pine-oak wood, leg. E. Pedroza, 10.VIII.2002, UACJ 1109 in AH 37810. Municipality of Chihuahua, CUMBRES DE MAJALCA, in cypress-oak wood, leg. M. Lizárraga, 15.XI.2003, UACJ 1117 in AH 37809.

OBSERVATIONS — *Lycoperdon atropurpureum* is characterized by a gleba with purplish to violaceous tinges, an alveolate, well-developed subgleba, and exoperidia with well-formed, brown, slender, simple, fragile spines. Microscopically, the species exhibits a *Lycoperdon*-type capillitium of reddish brown, thick-walled capillitial threads with abundant, small pores and 4.5–6 µm broad, globose, coarsely verrucose basidiospores. Under the SEM, stout, conical spines can be observed on the spores.

Although Kreisel (1973), (Ortega et al. 1985), and Calonge (1998) regarded *L. decipiens* and *L. atropurpureum* as synonyms, Jeppson (1987) and Jeppson & Demoulin (1989) disagreed. Recent molecular studies have confirmed that the two species are distinct (Larsson & Jeppson 2008).

Although previous records of this taxon from Mexico exist (Calonge et al. 2004), it is reported here for the first time from Chihuahua.

Lycoperdon eximium Morgan, J. Cincinnati Soc. Nat. Hist. 14: 15 (1891)

FIGS. 12–13

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ocampo, BASASEACHIC, in pine wood, leg. M. Hernández, 22.VIII.2002, UACJ 1108 in AH 37859.

OBSERVATIONS — Basidiomes pyriform, 3.5 cm high × 2.5 cm diam. Exoperidium comprising small, isolated verrucae and small, dark brown spines,

occasionally joined apically with other spines. Endoperidium membranous, light brown. Gleba brown with lilaceous tones. Subgleba well-developed, 1.3 cm in length and 2 cm broad, cellular; cells up to 1 mm in diam. Capillitium of the *Lycoperdon*-type; capillitial threads 2–5 μm in diam., reddish brown, pitted. Spores 5–6 \times 4–5 μm , ellipsoid, or rarely subglobose, smooth to verruculose, with a short pedicels. Spore ornamentation formed of abundant, dense verrucae, occasionally joined at their tips to form short ridges.

Our collection agrees well with the description of Coker & Couch (1928). This species is characterized by its cellular, well-developed subgleba, *Lycoperdon*-type capillitium, pored capillitial threads, and ellipsoid spores. *Lycoperdon eximium* is similar to *L. oblongisporum*, which Kreisel (1967) transferred to *Bovista* as *B. longispora* Kreisel, the epithet “*oblongispora*” having been used previously by Bottomley (1948) and thus not available. Although both *B. oblongispora* (Lloyd) Bottomley and *B. longispora* have ellipsoid spores, both species have very little to absent subgleba (Dennis 1953).

Previous records of *Lycoperdon eximium* from Valle de México exist (Herrera 1963); however, it is reported here for the first time from Chihuahua.

***Lycoperdon lividum* Pers., J. Bot. (Desvaux) 2: 18 (1809)**

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Bocoyna, SAN JUANITO, under *Pinus* sp., leg. M.C. Natividad, B. Marín & M.A. Samaniego, 11.VIII.2001, UACJ 1115 in AH 37858.

OBSERVATIONS — Recognized by its pale brown, slightly granulose exoperidium; gleba greenish, subgleba alveolate, capillitium with abundant pores and 4.5–5.5 μm broad, rugose basidiospores.

Recently reported from the Mexican states of Baja California, Jalisco, Oaxaca, Tlaxcala, and Veracruz (Calonge et al. 2004), *L. lividum* is reported here for the first time from Chihuahua.

***Lycoperdon marginatum* Vittad. ex Moris & De Not., Fl. Caprar.: 226 (1839)**

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Bocoyna, SAN JUANITO, under *Pinus* sp., leg. M.C. Natividad, B. Marín & M.A. Samaniego, 11.VIII.2001, AH 37819. Ibidem, leg. A. Franco & J. Muñoz, 8.IX.2002, UACJ 1113 in AH 37820.

OBSERVATIONS — *Lycoperdon marginatum* is principally recognized by its exoperidium with pyramidal verrucae (frequently composed 3–5 apically convergent spines) and that sloughs off the exoperidium in small plates as the fungus matures. This species is microscopically distinguished by verruculose spores that measure (3.2–)4.0–4.8(–5.6) μm in diam.

In their SEM examinations, Ochoa & Moreno 2006 observed no significant spore ornamentation differences in the Mexico and Spain collections. Laferrière & Gilbertson (1992) previously reported *L. marginatum* from Chihuahua.

Lycoperdon perlatum Pers., Observ. Mycol. (Lipsiae) 1: 4 (1796)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ocampo, BASASEACHIC, on litter in pine-oak wood, leg. J. Aguilar, 26.VIII.2002, UACJ 1157 in AH 37817.

OBSERVATIONS — This species is easily recognized by its exoperidium of fragile, conical spines surrounded by a persistent, circular row of warts resembling a pearl necklace, a *Lycoperdon*-type capillitium with pores, and globose, 3.5–4.5 µm broad, verrucose spores.

Lycoperdon perlatum has been frequently cited in the Mexican mycobiota (Calonge et al. 2004). Reported from Chihuahua by Pérez-Silva & Aguirre-Acosta (1986), Quiñónez-Martínez et al. (1999, 2005), and Quiñónez-Martínez & Garza-Ocañas (2003).

Lycoperdon pyriforme Schaeff., Fung. Bavar. Palat. 4: 128 (1774)

= *Morganella pyriformis* (Schaeff.) Kreisel & D. Krüger, Mycotaxon 86: 175 (2003)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ocampo, BASASEACHIC, on decaying *Pinus* sp. wood, leg. M. Lizárraga & J. Vargas, 6.V.2000, UACJ 1111 in AH 37823.

OBSERVATIONS — This species is recognized by its typically pyriform basidiomes with abundant, whitish, basal mycelial cords and its characteristic lignicolous habitat. The exoperidium is verruculose-granulose and spores are 3–4 µm in diam. and smooth to verruculose.

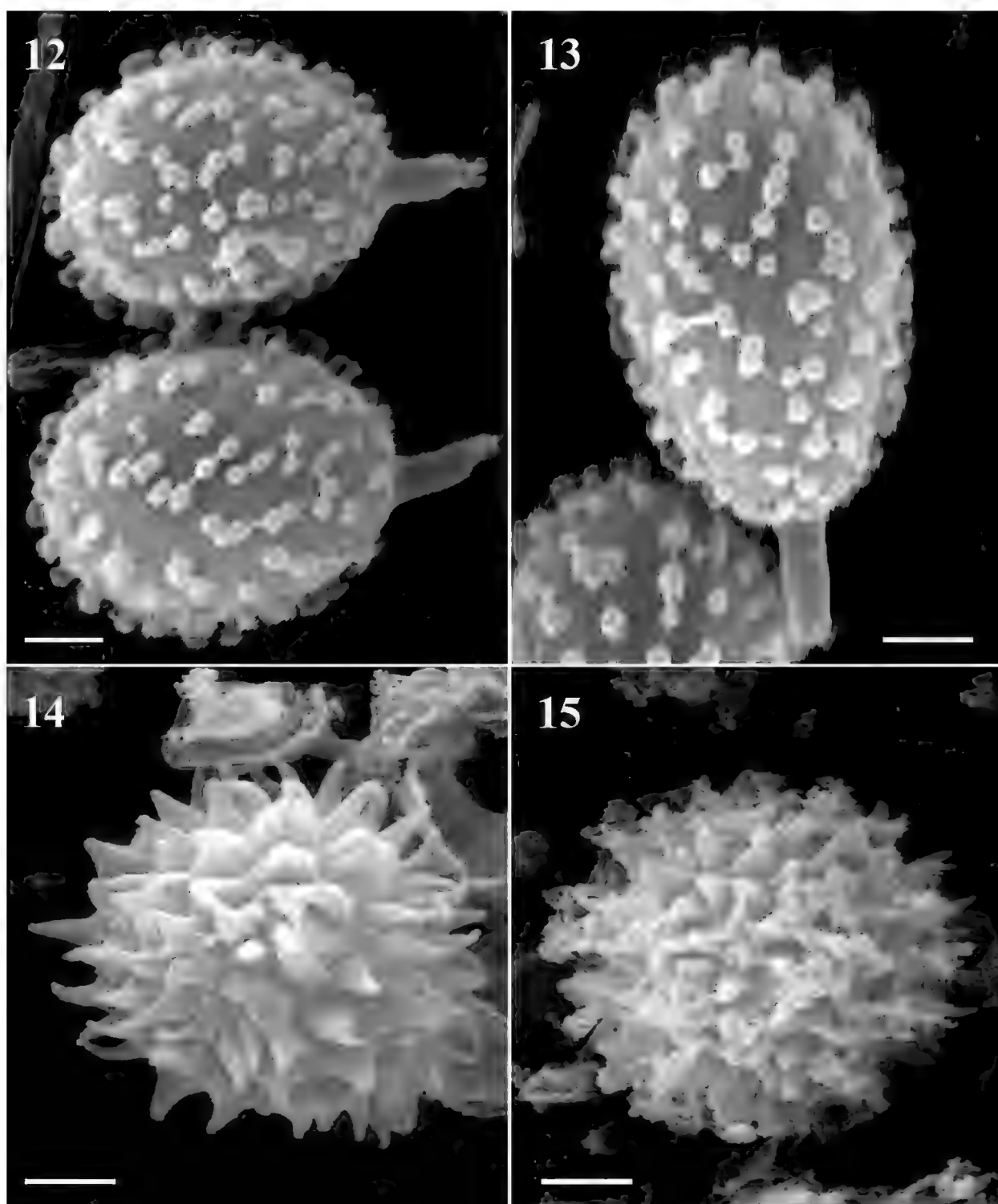
Krüger & Kreisel (2003) placed this species in *Morganella* Zeller (as *M. pyriformis*) based on molecular data. The molecular phylogenetic study of Larsson & Jeppson (2008), which included a broader sample of species in *Lycoperdaceae*, retains this species in *Lycoperdon*. Ochoa & Moreno (2006) studied spores of material from Baja California under SEM.

Lycoperdon pyriforme was first reported from Chihuahua by Laferrière & Gilbertson (1992).

Montagnea arenaria (DC.) Zeller, Mycologia 35: 418 (1943)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, KM 10 CIUDAD JUÁREZ TO JANOS ROAD, next to *Larrea tridentata*, leg. M. Lizárraga, 26.VIII.2000, UACJ 1140. KM 12 SAN JERÓNIMO TO CD. JUÁREZ ROAD, in sandy soil, leg. A. Franco & S. Escobar, 17.IX.2002, UACJ 1141. SAMALAYUCA, RANCHO EL ZORRO PLATEADO, leg. F. García & F. Piñera, 24.V.2003, UACJ 1142 in AH 37839. SIERRA DE JUÁREZ, in sandy soil, leg. A. Aguirre, 9.XII.2006, UACJ 1138. SIERRA DE SAMALAYUCA, in sandy soil, leg. C. Salazar, 16.III.2007, UACJ 1137.

OBSERVATIONS — *Montagnea arenaria* is characterized by its pileus having an apical disc, radial gills, a hymenophore, and spores with a prominent germ pore.



FIGS. 12–13: *Lycoperdon eximium* AH 37859. 12. Spores. 13. Spore ornamentation detail. FIG. 14: *Scleroderma areolatum* AH 37813. Spore. FIG. 15: *S. verrucosum* AH 37814. Spore. Scale bar 12–13 = 1 μ m; 14–15 = 2 μ m.

Hopple & Vilgalys (1999) studied the taxonomic position of *Montagnea* Fr.; their sequence analyses placed *M. arenaria* in the same clade as *Podaxis pistillaris* and members of *Coprinus* section *Comati* and the genus *Leucocoprinus*, thereby confirming the hypothesis of Singer (1986).

Spore sizes [(6–)7–8(–9) × (4–)5(–6) µm] in the collections studied here differ from those reported by Dios et al. (2001) based on Argentine collections (13–16 × 10–12 µm). This variation in spore size is frequently found among basidiomes in the same collection. Chen (1999) concluded in a study of the genus that “there is extraordinary variation in the size and shape of the fruiting bodies and spores of *Montagnea*” and indicated a wide spore size variation of 7–22 × 4.5–14 µm.

Although it is frequently observed in xerophytic areas of Chihuahua, this is the first published report of *Montagnea arenaria* for Chihuahua.

Mycenastrum corium (Guers.) Desv., Ann. Sci. Nat., Bot., Sér. 2, 17: 147 (1842)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Casas Grandes, CASAS GRANDES, in grassland, leg. M. Andrew & M. Vargas, 19.VIII.2001, UACJ 1144. Municipality of Juárez, CIUDAD JUAREZ, in Escuela de Veterinaria Inst. Ciencias Biomédicas, a garden, leg. S. Escobar & M. Lizárraga, 13.VI.2006, UACJ 1145.

OBSERVATIONS — Recognized by its thick peridium which stelliform splitting at apical portion, spores 8–12 µm in diam., reticulate and capillitium cyanophilous with numerous spinose projections. This taxon was first reported for Chihuahua by Laferrière & Gilbertson (1992).

Pisolithus arhizus (Scop.) Rauschert, Z. Pilzk. 25: 51 (1959)

= *Pisolithus tinctorius* (Pers.) Coker & Couch, Gast. East. U.S. Canada: 170 (1928)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Janos, PRESA CASA DE ADOBE, in riparian vegetation next to *Quercus* sp., leg. J. Martínez, S. Herrera & I. Márquez, 22.III.2001, UACJ 1158. Municipality of Chihuahua, KM 80 NAMIQUIPA TO CHIHUAHUA WAY, next to *Quercus* sp., leg. S. Herrera, 28.VIII.2003, UACJ 1159. Municipality of Madera, PRESA PEÑITAS, leg. M. Lizárraga, 23.VIII.2003, next to *Quercus* sp., UACJ 1160.

OBSERVATIONS — This taxon is recognized by its 9–13 µm broad, globose, spinulose basidiospores.

Pisolithus arhizus has been frequently reported for Mexico and is mainly associated with *Pinus* and *Quercus* (Calonge et al. 2004). It forms a complex comprising several taxa that are easily differentiated at the molecular level, but not morphologically.

Guzmán & Herrera (1973) previously reported *P. arhizus* from Chihuahua.

Podaxis pistillaris (L.) Fr., Syst. Mycol. 3: 63 (1829)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, CIUDAD JUÁREZ, URBAN ZONE, next to *Prosopis* sp., leg. J. Martínez, 15.VI.2001, UACJ 1137. CAMPUS DEL INSTITUTO DE CIENCIAS BIOMÉDICAS, UNIV. AUTÓNOMA CIUDAD JUÁREZ, in sandy soil, leg. I. Márquez y J. Martínez, 25.VIII.2001, UACJ 1522. Ibidem, associated with *Larrea tridentata*, leg. I. Baca & W. Coronado, 13.VIII.2002, UACJ 1136. KM 12 SAN JERÓNIMO TO JUÁREZ ROAD, associated with *Larrea tridentata*, leg. A. Franco, J. Soto &

S. Escobar, 17.IX.2002, *UACJ* 1138. SAMALAYUCA, RANCHO ZORRO PLATEADO, in sandy soil, leg. J. Córdoba, 25.V.2003, *UACJ* 1139.

OBSERVATIONS — Recognized by its basidiome dehiscence by an irregular rupture at pileus base, spores $9.5\text{--}17 \times 8.5\text{--}13.5 \mu\text{m}$, broadly ellipsoid to oval, with a thick double-walled, prominent germ pore.

The large variability in basidiome and spore size exhibited by *Podaxis pistillaris* has produced taxonomic confusion.

A solitary to gregarious species typical of xeric areas, *P. pistillaris* is commonly found in the Municipality of Juárez, including urban zones. This is the first report from Chihuahua.

Schizostoma laceratum (Ehrenb. ex Fr.) Lév., Ann. Sci. Nat., Bot., Sér. 3, 5: 163 (1846), as “*lacerum*”

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, SAMALAYUCA, in sandy soil, leg. M. Lizárraga, 4.III.2001, *UACJ* 1135 in *AH* 37846. Municipality of Cuahutemoc, RANCHO EL CASTILLO, located between Coyame and Cuauhtémoc, in xeric area with *Larrea tridentata* and *Prosopis* sp. leg. J. Vargas, *UACJ* 1143.

OBSERVATIONS — Two collections of isolated specimens. Basidiome stipitate, up to 6.3 cm total tall. Spore sac subglobose of $1.5\text{--}2 \times 2\text{--}2.5 \text{ cm}$, with a petaloid dehiscence produced by irregular fissuring downwards from the apex. Stipe white, $3\text{--}4 \times 0.3\text{--}0.6 \text{ cm}$, which goes inside spore sac such as a columella. Exoperidium not observed. Capillitium $4\text{--}10 \mu\text{m}$ in diam., reddish brown to ochraceous red, with isolated filaments, thick-walled, with short and scarce branches which have obtuse endings; capillitium remains in the endoperidium and columella wall when maturing. Spores of $5\text{--}5.5 \mu\text{m}$ in diam., globose to subglobose, smooth.

Moreno et al. (1995) presented a macro- and microscopical study of this rare species, including SEM micrographs, based on collections from Baja California. This is the first report for *Schizostoma laceratum* from Chihuahua.

Scleroderma areolatum Ehrenb., Sylv. Mycol. Berol. (Berlin): 27 (1818)

FIG. 14

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, CAMPUS OF INSTITUTO DE CIENCIAS BIOMÉDICAS, CENTRO DE IDIOMAS, UNIV. AUTÓNOMA CIUDAD JUÁREZ, in a garden with *Salix* sp., leg. M. Lizárraga, 26.IX. 2007, *UACJ* 1084 in *AH* 37813.

OBSERVATIONS — Basidiome small, 1–5 cm in diam., surface bruising instantly purplish to reddish with 5% KOH, peridium with small brownish scales, without a stem or occasionally with a poorly defined pseudostipe. Spores $12\text{--}16 \mu\text{m}$ in diam., globose, densely spiny but not reticulate; with spines up to $2 \mu\text{m}$ long. Under SEM spore ornamentation seen to be formed by large, conical spines that rarely join at apex.

Sims et al. (1995) constructed a key to the genus based mainly on spore ornamentation (spinulose, subreticulate, or reticulate), after which Guzmán & Ovrebo (2000) proposed a new genus section and cited a new species in the American Continent. *Scleroderma areolatum* has been confused with *S. verrucosum* (Guzmán 1970), which is treated below.

First reported in Chihuahuan mycobiota by Quiñónez-Martínez et al. (1999) and Quiñónez-Martínez & Garza-Ocañas (2003).

Scleroderma cepa Pers., Syn. Meth. Fung. (Göttingen) 1: 155 (1801)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Chihuahua, CUMBRES DE MÁJALA, in oak-cypress wood, leg. M. Lizárraga & H. Pelayo, 15.XI.2003, UACJ 1083 in AH 37812.

OBSERVATIONS — *Scleroderma cepa* is characterized by spinulose 9–12 µm broad spores and a smooth, white peridium that becomes pinkish-brown to dark brown when handled or becomes mature. The surface is often cracked or areolate but not with raised warts as in *S. citrinum* which can be further distinguished by reticulate rather than spinulose spores (Kuo, 2004).

Guzmán & Herrera (1973) and Pérez-Silva & Aguirre-Acosta (1986) previously reported *S. cepa* for Chihuahua.

Scleroderma verrucosum (Bull.) Pers., Syn. Meth. Fung.

(Göttingen) 1: 154 (1801)

FIG. 15

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Guadalupe, SIERRA LA AMARGOSA, associated with *Quercus* sp., *Prosopis* sp. and *Larrea tridentata*, leg. C. Arteaga, 28.X.2007, UACJ 1085 in AH 37814.

OBSERVATIONS — Characterized by its fragile peridium (≤ 1 mm thick in the dry basidiome) with small scales at maturity, generally well-developed pseudostipe, globose 9–12 µm broad in spores, and episporium formed by thick pyramidal spines.

Pérez-Silva & Aguirre-Acosta (1986) and Laferrière & Gilbertson (1992) reported *S. verrucosum* for Chihuahua.

Tulostoma albicans V.S. White, Bull. Torrey Bot. Club 28: 428 (1901)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Casas Grandes, KM 36 CASAS GRANDES TO CD. JUÁREZ ROAD, leg. D. Mejía, 7.X.2005, next to *Larrea tridentata*, UACJ 1076 in AH 37841.

OBSERVATIONS — *Tulostoma albicans* is recognized by its thin but clearly membranous exoperidium, circular mouth, and spores that are 4.5–5.5 µm in diam., globose, smooth to verruculose. Under SEM the spore ornamentation appears as small and irregular verrucae, some of which are anastomosed (Esqueda et al. 2004).

This is the first report of this species from Chihuahua.

Tulostoma cretaceum Long, Mycologia 36: 321 (1944)

FIG. 16

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, SAMALAYUCA, RANCHO EL ZORRO PLATEADO, leg. T. Rubalcaba & G. García, 20.IV.2003, in sandy soil, UACJ 1092 in AH 37834. ARROYO DE LAS VÍBORAS, SIERRA DE JUÁREZ, leg. A. Aguirre, 9.XII.2006, UACJ 1066 in AH 37835.

OBSERVATIONS — Characterized by its whitish basidiome, hyphal exoperidium that is mixed with sand, fibrillose stoma that becomes indefinite when mature, cylindric stalk that arises from a conspicuous basal mycelial cord, filamentous branched septate capillitium, and smooth globose to subglobose spores 5–6 μm in diam.

When the fruiting body is enlarged, it can be confused with *Tulostoma obesum*, but that species generally has a straight stalk with a non-radicating (usually volviform) base, and capillitium broken into branches, seen under LM as dichotomous endings.

Known only from xeric areas in Baja California (Moreno et al. 1995) and Sonora (Esqueda et al. 2004). This is the first report of *T. cretaceum* for Chihuahua.

Tulostoma fimbriatum Fr., Syst. Mycol. 3: 43 (1829)

FIG. 17

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Ahumada, EL SUECO, EJIDO BELLAVISTA, next to *Larrea tridentata*, leg. J. Martínez, 21.VII.2001, UACJ 1088 in AH 37844.

OBSERVATIONS — This taxon is recognized by its fimbriate stoma, hyphal exoperidium, and spores 5–6 μm in diam., globose, with verrucose and subreticulate ornamentation.

Within the genus *Tulostoma*, this is one of the most widely distributed species worldwide. This is the first report for *T. fimbriatum* from Chihuahua.

Tulostoma involucratum Long, Mycologia 36: 330 (1944)

FIG. 18

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, VALLE DE JUÁREZ, ARROYO CERCANO, next to *Larrea tridentata*, leg. J. Vargas, 6.VI.2000, UACJ 1063 in AH 37843.

OBSERVATIONS — This species is characterized by its membranous exoperidium, tubular stoma, and echinulate spores [5–6(–7) μm diam] under LM and large compound verrucae under SEM. Specimens showed a conspicuous ellipsoid, short tubular stoma.

Esqueda et al. (2004) reported *T. involucratum* for the first time in Mexico; this is the first report for Chihuahua.

Tulostoma macrosporum G. Cunn., Proc. Linn. Soc. N.S.W. 50: 252 (1925) FIG. 19

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, CERRO EL MESUDO, KM 17.5 CIUDAD JUÁREZ TO JANOS ROAD, in xerophytic scrub, leg. C. Salazar & M. Lizárraga, 23.V.2007, UACJ 1073 in AH 37827 and UACJ 1156. Ibidem, in sandy soil, leg. M. Vargas, R. Carrasco & D. Sáenz, 20.IV.2008, UACJ 1079 in AH 37826.

OBSERVATIONS — This species is recognized by its short tubular stoma, thinly membranous exoperidium, and mainly because of its spore size [8–12(–14) μm in diam.]. Spore ornamentation is formed by thick spines which are occasionally joined forming a short wave under SEM.

Altés & Moreno (1999), who conducted type studies A study with type materials of *T. macrosporum*, *T. meridionale* J.E. Wright, and *T. utahense* J.E. Wright, recognized *T. macrosporum* and *T. utahense* as autonomous taxa, and synonymised *T. meridionale* with *T. utahense*.

Tulostoma macrosporum is little known in the Mexican mycobiota (Esqueda et al. 2004; Calonge et al. 2004, 2007). This is the first report for Chihuahua.

Tulostoma melanocyclum Bres., Ann. Mycol. 2: 415. 1904.

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Madera, ZONA ARQUEOLÓGICA DE 40 CASAS, in litter of *Quercus* sp., leg. A. Jiménez-Leyva, 23.VIII.2003, UACJ 1075 in AH 37825.

OBSERVATIONS — *Tulostoma melanocyclum* is mainly recognized by its macroscopical similarity to *T. brumale* Pers. and spores [5–6.5 μm in diam.] that appear echinulate under LM and with large spines fused at the apex under SEM (Esqueda et al. 2004).

This is the first report of *T. melanocyclum* for Chihuahua.

Tulostoma obesum Cooke & Ellis, Grevillea 6: 82 (1878)

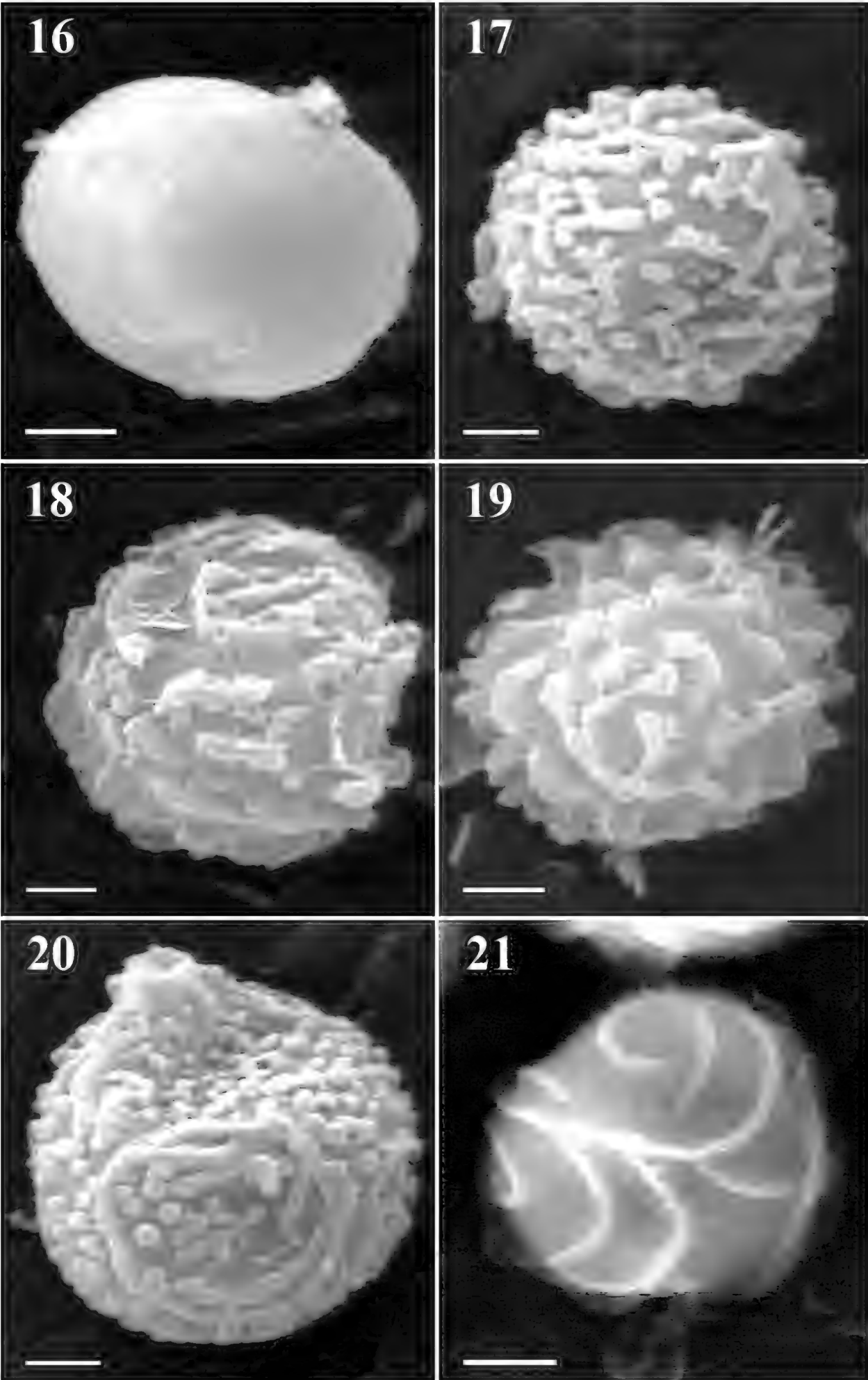
= *Tulostoma volvulatum* sensu auct., non *T. volvulatum* I.G. Borshch. (1865)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, CERRO EL MESUDO, KM 17.5 CIUDAD JUÁREZ TO JANOS ROAD, in xerophytic scrub, leg. C. Salazar & M. Lizárraga, 23.V.2007, UACJ 1067 in AH 37845.

OBSERVATIONS — Basidiome whitish, stoma rapidly becoming indefinite when maturing, stalk generally with a volviform base; capillitium thick-walled, septate, fragile, spores smooth, globose and frequently deformed shape, 5–6 μm in diam.

Altés et al. (1999) have summarized the taxonomic difficulties surrounding *T. obesum*. The species was known only in the Mexican mycobiota for Sonora (Esqueda et al. 2004), and this is the first report for Chihuahua.

FIG. 16: *Tulostoma cretaceum* AH 37835. Spore. FIG. 17: *T. fimbriatum* AH 37844. Spore. FIG. 18: *T. involucreatum* AH 37843. Spore. FIG. 19: *T. macrosporum* AH 37826. Spore. FIG. 20: *T. pulchellum* var. *subfuscum* AH 37835. Spore. FIG. 21: *T. striatum* AH 37838. Spore. Scale bar 16–18, 20–21 = 1 μm ; 19 = 2 μm .



Tulostoma pulchellum* var. *subfuscum (V.S. White) J.E. Wright, G. Moreno &

Altés, Mycotaxon 43: 483 (1992)

FIG. 20

≡ *Tulostoma subfuscum* V.S. White, Bull. Torrey Bot. Club 28: 433 (1901)

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez SAN JERÓNIMO, KM 10 ASCENSIÓN TO CIUDAD JUÁREZ ROAD, next to *Prosopis glandulosa*, leg. R. Martínez, 23.IV.2002, UACJ 1071 in AH 37835.

OBSERVATIONS — Recognized by its clearly membranous exoperidium, fibrillose, fimbriate and scutellate stoma, and basidiospores that are 4.5–6 µm in diam. and seen under SEM with dense verrucae and waves of variable length and shape.

This taxon is macro- and microscopically similar to *Tulostoma pulchellum* Sacc., which is distinguished by a spore ornamentation that is also verrucose but lacks waves. For this reason, Moreno et al. (1992) proposed it as a variety of *T. pulchellum* as originally suggested by Wright (1987). Calonge et al. (2004) recently reported the variety for Mexico based on a single incomplete basidiome from Baja California. The Chihuahuan collection has four complete basidiomes and one spore sac.

Tulostoma striatum G. Cunn., Proc. Linn. Soc. N.S.W. 50: 255 (1925)

FIG. 21

SPECIMENS EXAMINED — MEXICO. CHIHUAHUA: Municipality of Juárez, VALLE DE JUÁREZ, EJIDO EL MILLÓN, in sandy soil, leg. T. Rubalcaba, J. Martínez, M. Ramírez & C. Muñoz, 19.IX.2001, UACJ 1089 in AH 37838.

OBSERVATIONS — This species is distinguished by the usually obese spore sac, a rather short stipe, a clearly membranous exoperidium, fibrillose-fimbriate stoma, and spores [5–6.5 µm in diam.] with striate ornamentation (Esqueda et al. 2004). Although *T. striatum* is represented by only one spore sac in the UACJ herbarium, the typical basidiospore size (4–6 µm in diam.) and ornamentation is sufficient to confirm its identity.

This is the first record for *Tulostoma striatum* from Chihuahua.

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Literature cited

- Altés A, Moreno G. 1999. Notes on type materials of *Tulostoma* (*Tulostomataceae*) *T. macrosporum*, *T. meridionale* and *T. utahense*. *Persoonia* 17: 259–264.
- Altés A, Moreno G, Wright JE. 1999. Notes on *Tulostoma volvulatum* and *T. giovanellae*. *Mycological Research* 103: 91–98.
- Bates ST. 2004. *Arizona Members of the Geasteraceae and Lycoperdaceae (Basidiomycota, Fungi)*. Master thesis. Arizona State University, Tempe.
- Bates ST, Roberson RW, Desjardin DE. 2009. Arizona gasteroid fungi I: *Lycoperdaceae* (*Agaricales, Basidiomycota*). *Fungal Diversity* 37: 153–207.
- Brodie HJ. 1975. *The bird's nest fungi*. Univ. Toronto Press. Toronto and Buffalo. 199 p.
- Bottomley AM. 1948. *Gasteromycetes* of South Africa. *Bothalia* 4: 473–810.
- Calonge FD, Guzmán G, Ramírez-Guillén F. 2004. Observaciones sobre los gasteromycetes de México depositados en los herbarios XAL y XALU. *Boletín de la Sociedad Micológica de Madrid* 28: 337–371.
- Calonge FD, Mata M, Carranza J. 2005. Contribución al catálogo de los gasteromycetes (*Basidiomycotina, Fungi*) de Costa Rica. *Anales del Jardín Botánico de Madrid* 62: 23–45.
- Calonge FD, Guzmán G, Ramírez-Guillén F, Gándara E. 2007. Adiciones al catálogo de *Gasteromycetes* de México, con referencia especial a los géneros *Blumenavia* y *Tulostoma*. *Boletín de la Sociedad Micológica de Madrid* 31: 151–155.
- Calonge FD. 1998. *Flora Micológica Ibérica*. Vol. 3. *Gasteromycetes* I. *Lycoperdales, Nidulariales, Phallales, Sclerodermatales, Tulostomatales*. J. Cramer, Stuttgart. 271 p.
- Chen C. 1999. Genetical and molecular systematic study on the genus *Montagnea* Fr., a desert adapted *Gasteromycete*. Thesis, Master of Science, Faculty of the Virginia Polytechnic Institute and State University. 74 p.
- Coker WC, Couch JN. 1928. *The Gasteromycetes of the Eastern United States and Canada*. University of North Carolina Press, Chapel Hill. 201 p.
- Dennis RWG. 1953. Some West Indian *Gasteromycetes*. *Kew Bulletin* 8: 307–328.
- Dios MM, Moreno G, Altés A, D'Angelo MV. 2000. Algunos *Gasteromycetes* interesantes de Catamarca, Argentina. *Mycologia* 2000, Associazione Micologica Bresadola. 711 p.
- Dios MM, Moreno G, Altés A. 2001. *Podaxis argentinus* and other species of *Podaxaceae* from Catamarca, Argentina. *Mycotaxon* 80: 453–460.
- Esqueda M, Moreno G, Pérez-Silva E, Sánchez A, Altés A. 2004. The genus *Tulostoma* in Sonora, México. *Mycotaxon* 90: 409–422.
- Geml J, Geiser DM, Royse DJ. 2004. Molecular evolution of *Agaricus* species based on ITS and LSU rDNA sequences. *Mycological Progress* 3: 157–176.
- Guzmán G. 1970. Monografía del género *Scleroderma* Pers. emend. Fr. *Darwiniana* 16: 233–407.
- Guzmán G, Herrera T. 1973. Especies de macromicetos citadas de México, IV. *Gasteromicetos*. *Boletín de la Sociedad Mexicana de Micología* 7: 105–119.
- Guzmán G, Ovrebo CL. 2000. New observations on sclerodermataceous fungi. *Mycologia* 92: 174–179.
- Herrera T. 1960 (“1959”). *Bovista y Scleroderma* en el Valle de Mexico. *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México* 30: 35–57.

- Herrera T. 1963. Especies de *Lycoperdon* del Valle de México. Anales del Instituto de Biología de la Universidad Nacional Autónoma de México 34: 43–68.
- Hopple JS Jr, Vilgalys R. 1999. Phylogenetic relationships in the mushroom genus *Coprinus* and dark-spored allies based on sequence data from the nuclear gene coding for the large ribosomal subunit RNA: Divergent domains, outgroups, and monophyly. Molecular Phylogenetics and Evolution 13: 1–19.
- Jeppson M. 1987. Notes on some Spanish gasteromycetes. Boletín de la Sociedad Micológica de Madrid 11: 267–282.
- Jeppson M, Demoulin V. 1989. *Lycoperdon atropurpureum* found in Sweden. Opera Botanica 100: 131–134.
- Kreisel H. 1967. Taxonomisch-Pflanzengeographische monographie der gattung *Bovista*. Beihefte Zur Nova Hedwigia 25: 1–243.
- Kreisel H. 1973. Die *Lycoperdaceae* der deutschen demokratischen Republik. Nachträgen 1962–1971. Bibliotheca Mycologica 36: 1–13.
- Krüger D, Kreisel H. 2003. Proposing *Morganella* subg. *Apioperdon* subg. nov. for the puffball *Lycoperdon pyriforme*. Mycotaxon 86: 169–177.
- Kuo M. 2004. The genus *Scleroderma*. <http://www.mushroomexpert.com/scleroderma.html>. June 2009.
- Laferrière JE, Gilbertson RL. 1992. Fungi of Nabogame, Chihuahua, México. Mycotaxon 44: 73–87.
- Larsson E, Jeppson M. 2008. Phylogenetic relationships among species and genera of *Lycoperdaceae* based on ITS and LSU sequence data from north European taxa. Mycological Research 112: 4–22.
- Larsson E, Jeppson M, Larsson K-H. 2009. Taxonomy, ecology and phylogenetic relationships of *Bovista pusilla* and *B. limosa* in North Europe. Mycological Progress 8: 289–299.
- Lazo W. 1972. Fungi from Chile I. Some *Gasteromycetes* and *Agaricales*. Mycologia 64: 786–798.
- Lloyd CG. 1902. The *Geastrae*. Bulletin of the Lloyd Library, Mycological Series 2: 1–44.
- Moreno G, Altés A, Wright JE. 1992. *Tulostoma pseudopulchellum* sp. nov. (*Tulostomatales*, *Gasteromycetes*) and allied species. Mycotaxon 43: 479–486.
- Moreno G, Altés A, Ochoa C, Wright JE. 1995. Contribution to the study of the *Tulostomataceae* in Baja California, Mexico. I. Mycologia 87: 96–120.
- Moreno G, Altés A, Ochoa C. 2003. Notes on some type materials of *Disciseda* (*Lycoperdaceae*). Persoonia 18: 215–223.
- Moreno G, Esqueda M, Pérez-Silva E, Herrera T, Altés A. 2007. Some interesting gasteroid and secotioid fungi from Sonora, México. Persoonia 19: 265–280.
- Moreno-Fuentes A, Aguirre-Acosta E, Villegas M, Cifuentes J. 1994. Estudio fungístico de los macromicetos en el municipio de Bocoyna, Chihuahua, México. Revista Mexicana de Micología 10: 63–76.
- Ochoa C, Moreno G. 2006. Hongos gasteroides y secotioides de Baja California, México. Boletín de la Sociedad Micológica de Madrid 30: 121–166.
- Ortega A, Buendia AG, Calonge FD. 1985. Estudio de algunas especies interesantes del género *Lycoperdon* (*Gasteromycetes*) en España. Boletín de la Sociedad Micológica Castellana 9: 141–148.
- Pérez-Silva E, Aguirre-Acosta E. 1986. Flora micológica del estado de Chihuahua, México I. Anales del Instituto de Biología de la Universidad Nacional Autónoma de México, Serie Botánica 57: 17–32.

- Pérez-Silva E, Herrera T, Esqueda M. 1999. Species of *Geastrum* (*Basidiomycotina: Geastraceae*) from Mexico. *Revista Mexicana de Micología* 15: 89–104.
- Pérez-Silva E, Esqueda M, Herrera T, Moreno G, Altés A. 2000. *Disciseda verrucosa* (Gasteromycetes) in Mexico. *Mycotaxon* 76: 337–341.
- Phosri C, Watling R, Martín MP, Whalley AJS. 2004. The genus *Astraeus* in Thailand. *Mycotaxon* 89: 453–463.
- Phosri C, Martín MP, Sihanonth P, Whalley AJS, Watling R. 2007. Molecular study of the genus *Astraeus*. *Mycological Research* 111: 275–285.
- Ponce de León P. 1946. El género *Geastrum* en Cuba. *Revista de la Sociedad Cubana de Botánica* 3: 63–70.
- Quiñónez M, Garza F, Mendoza JR, García J, Sáenz J, Bolaños H. 1999. Guía de Hongos de la Región de Bosque Modelo Chihuahua. Universidad Autónoma de Chihuahua, Universidad Autónoma de Nuevo León, Instituto Tecnológico de Ciudad Victoria y Bosque Modelo Chihuahua, A.C., Chihuahua. 118 p.
- Quiñónez M, Garza F. 2003. Taxonomía, ecología y distribución de hongos macromicetos de Bosque Modelo, Chihuahua. *Ciencia en la Frontera, Revista de Ciencia y Tecnología de la Universidad Autónoma de Ciudad Juárez* 2: 163–169.
- Quiñónez M, Garza F, Vargas M. 2005. Aspectos ecológicos y diversidad de hongos ectomicorrízicos en bosque de pino y encino de 5 localidades del municipio de Bocoyna, Chihuahua. *Ciencia en la Frontera, Revista de Ciencia y Tecnología de la Universidad Autónoma de Ciudad Juárez* 3: 29–38.
- Rzedowsky J. 1978. *La Vegetación de México*. Limusa, México. 432 p.
- Singer R. 1986. *The Agaricales in modern taxonomy*. 4th ed. Koeltz Scientific Books, Koenigstein. 981 p.
- Sims KP, Watling R, Jeffries P. 1995. A revised key to the genus *Scleroderma*. *Mycotaxon* 56: 403–420.
- Smith AH. 1951. *Puffballs and their allies in Michigan*. University of Michigan Press, Ann Arbor. 131 p.
- Sunhede S. 1989. *Geastraceae (Basidiomycotina)*, morphology, ecology, and systematics with special emphasis on the North European species. *Synopsis Fungorum* 1: 1–534.
- Wright JE. 1987. The genus *Tulostoma* (Gasteromycetes). A world monograph. J. Cramer, Berlin-Stuttgart. 338 p.

A new species of *Engleromyces* from China, a second species in the genus

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Abstract — *Engleromyces sinensis* is described as new and its distinguishing characteristics are contrasted with those of *E. goetzei* from Africa. Its distribution and bamboo host in China are discussed and its connection to folk medicine noted.

Key words — *Ascomycota*, taxonomy, *Xylariaceae*

Introduction

Engleromyces Henn. was erected for a single species, *E. goetzei*, occurring in East Africa (Hennings 1900). *Engleromyces* has been considered to have affinities to *Sarcoxydon* Cooke and *Thuemenella* Penz. & Sacc. being intermediate between the xylariaceous and hypocreaceous fungi (Saccardo 1902). Von Arx & Müller (1954) placed the genera in synonymy although later they accepted separate status (Müller & Von Arx 1973). Dennis (1961) and Rogers (1981) maintained the separation and agreed that the genus belongs to the *Xylariaceae*. In his review of *Sarcoxydon* and *Entonaema* Möller, Rogers (1981) noted that the key features of *Engleromyces* are

“ ... its polystichous perithecia, whitish flesh, yellowish exterior crust having areas with punctate perithecial ostioles interspersed with sterile areas of tissue. The stroma is apparently rather soft when fresh. Old herbarium material is hard and horny, but becomes soft and somewhat gelatinous when soaked in water.”

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Rogers (1981) also stated that he was unable to confirm a massive amyloid apical ring as detailed by Dennis (1961) because of the poor condition of asci in the material he examined, and he suggested that the asci deliquesce at maturity. The ascospores were described as inequilateral and are often crescentric to C-shaped. Furthermore he noted that the ascospores appear to possess a germ pore of variable position and that the presence of truncate apices at one or both ends of the spores is suggestive of cellular appendages that had dehisced.

During a study of the family *Xylariaceae* in the Mycological Herbarium of the Chinese Academy of Sciences, Beijing (HMAS), two collections (five specimens total) from Yunnan Province, China that had been identified as *E. goetzei* were examined. Although providing a clear account of the overall features of this fungus, neither the original description of *E. goetzei* from Africa (Henning 1900) nor subsequent ones by Lloyd (1917), Dennis (1961), and Rogers (1981) provide details on such microscopical characters as the apical apparatus, the asci, and aspects of ascospore morphology. Examination and comparison of the Chinese material with collections from East Africa provided further information on asci and ascospores but also indicated a number of significant differences between the African and Chinese material. We therefore provide additional information on *Engleromyces* from Africa and describe the collections from China as a second species in the genus.

Taxonomy

Engleromyces sinensis M.A. Whalley, A. Khalil, T.Z. Wei, Y.J. Yao & Whalley.

sp. nov.

FIGS 1–6.

MYCOBANK MB 515459.

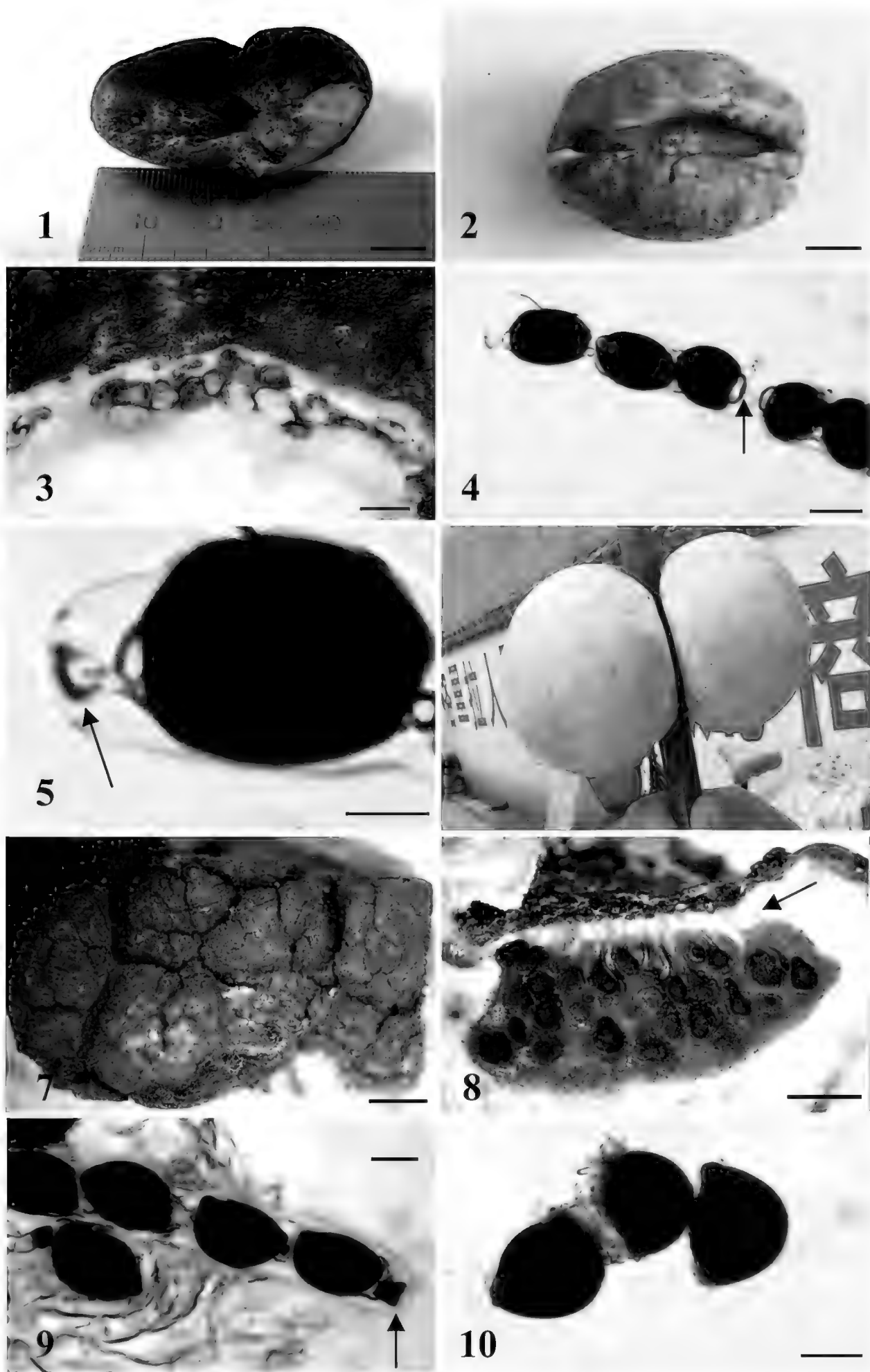
Stromata globosa vel subglobosa, 4.3–4.9 cm crassa × 4–5.5 cm longa et 1.6–4 cm alta, involuta culmi bambusae, pagino bubalina. Ostiola dispersa, plana vel pavum elevate. Annulo apicali in liquore iodata Melzeri cyanescente. Ascosporae atrae, late inequilaterales 15–19 × 11.5–12.5(–14) µm.

TYPE—Yunnan, China, Yulong County, Yulong mountain, 4 Nov 1958, S.-J. Han & L.-Y. Chen 5058, det. as *Engleromyces goetzei* [as “goetsii”] by S.-C. Teng, HMAS 32034 (Holotype)

Stromata seated on and partially enveloping bamboo culms forming two lobes, globose to subglobose, 4.3–4.9 × 4–5.5 cm and 1.6–4 cm in height. Surface

FIGS 1–6. *Engleromyces sinensis*. FIG. 1. Holotype, partially blackened stroma resulting from fire damage. FIG. 2. Immature specimen showing colour of stroma and position of bamboo culm. FIG. 3. Polystichous perithecial layer. FIG. 4. Ascus, showing ascospores with appendages (arrowed) and apical apparatus. FIG. 5. Funnel-shaped apical apparatus resembling a golf-tee (arrowed). FIG. 6. Fresh specimen in a Yunnan market, China. FIGS. 7–10. *Engleromyces goetzei*. FIG. 7. Surface of stroma. FIG. 8. Perithecia in discrete clusters, showing long ostiolar necks (arrowed). FIG. 9. Ascus, showing cuboid apical apparatus (arrowed). FIG. 10. Citriform ascospores.

Bar marker: FIGS 1 and 2, 1 cm; FIGS 3, 7 and 8, 2 mm; FIG. 4, 9 and 10, 10 µm; FIG. 5, 5 µm.



buff coloured with a pinkish hue when young, slightly dimpled when young becoming smoother and greyish brown with age. Internal flesh buff coloured, texture firm when fresh becoming woody. Ostioles scattered, slightly papillate becoming punctate with age. Perithecia polystichous, below a crust of ca. 1 mm, unevenly aggregated, spherical to flask shaped, asci 8-spored with apical apparatus blued in Melzer's Reagent, funnel or T-shaped, resembling a golf-tee, c. $4 \times 4 \mu\text{m}$. Ascospores uniseriate, black, smooth by SEM, broadly inequilateral with one or both ends truncate, with drop-like appendages visible on spores within the ascus, with no germ slit or pore observed, $15\text{--}19 \times 11.5\text{--}12.5$ ($\text{--}14$) μm .

ADDITIONAL COLLECTION EXAMINED: CHINA. YUNNAN: Yulong County, Yulong Mountain. 3000 m. on *Arundinaria*, 4 May 1974, M. Zang 46, det. as *Engleromyces goetzei* [as "*goetzii*"] by M. Zang, HMAS 40511.

Significant characteristic features differentiate the African and Chinese collections of *Engleromyces* and justify their separate taxonomic status. These differences include the overall size of the stromata, ascospore shape and dimensions, and the unique funnel or T-shaped apical apparatus present in the Chinese collections. There are a number of reports on this fungus, as *E. goetzei*, from China that compliment the description and provide additional data on distribution and ecology, e.g. from Muotuo County, Xiang (Tibet) at 2000–3500 m altitude in a coniferous forest with bamboo and also on bamboo culm in Yunnan, Sichuan (Mao et al. 1993, Mao 1998, 2000). Characters cited included stromata 6–10($\text{--}20$) cm in diameter, spore-containing asci subcylindric and $135\text{--}150 \times 16\text{--}19 \mu\text{m}$, ascospores $15\text{--}21 \times 11\text{--}15 \mu\text{m}$, and filiform paraphyses. Mao et al. (1993) and Mao (1998, 2000) also reported antibacterial properties and its medicinal use to reduce inflammation. Ying & Zang (1994) cited $120\text{--}150 \times 14\text{--}19 \mu\text{m}$ asci and $15\text{--}21 \times 11\text{--}15 \mu\text{m}$ ascospores for collections from Lijiang, Yunnan (HMAS 32034, 40511) and Xizang. Yuan & Sun (1995) provided similar descriptions for collections from Sichuan and Yunnan and pointed out that the fungus contains cytochalasin D, a toxin that inhibits cell division and which can be used to treat skin cancer.

Engleromyces goetzei Henn., Bot. Jahrb. Syst. 28: 327 (1900).

FIGS 7–10.

= *Stromne goetzei* (Henn.) Clem., Gen. fung. (Minneapolis): 44: 173 (1909).

Stromata seated upon and partially enveloping bamboo culms, subglobose up to 30 cm diameter, with an irregularly undulating, roughened surface, dark brown to black, with areas of orange pigmentation especially when young. Flesh solid, white, becoming light brown towards the surface. Perithecia oval to ellipsoid, 0.8–1 mm, compacted at different levels in a layer 3–4 mm deep, with long perithecial necks. Brown punctate ostioles scattered at the surface. Asci 8-spored, $103\text{--}121 \times 12\text{--}15 \mu\text{m}$ with a large cuboid apical apparatus, c. $4 \times 4 \mu\text{m}$

blued in Melzer's Reagent. Ascospores uniseriate, black, strongly inequilateral so as to appear citriform, $(17.5-20-24 \times 15-17.5 \mu\text{m})$, with no germ slit or pore observed, paraphyses not seen.

COLLECTIONS EXAMINED: AFRICA, KENYA: Kivale, S. Aberdare Mts., 7800 ft., June 1961, I.A.S. Gibson, K(M) 162110. RWANDA (Congo Belge): Kivu, Foret d'Arundinaria alpina, Shamulamda, Massif du Biega, Nov 1951, G. Fontana K(M) 162108. KENYA: Turi, 1958, Baker, K(M) 162109.

Dennis (1961) description of collections of *Engleromyces* from the DR Congo and Rwanda is broadly in line with the one given above, although his ascospore measurements $(22-27 \times 15-20 \mu\text{m})$ are slightly larger than in the material we examined. Rogers (1981), who examined material from Nyassa and Uganda in FH, noted that he was unable to confirm the massive apical ring blued by iodine because of the condition of the asci and indicated that the asci appear to deliquesce at maturity. He did, however, note what appeared to be a germ pore on the ascospores and also referred to the possible presence of cellular appendages. We have examined collections from Kenya and can confirm the presence of a large, cuboid, amyloid apical apparatus $4 \times 4 \mu\text{m}$, in some cases slightly tapering towards the base. Rogers (1981) also indicated that 'old herbarium material is hard and horny, but becomes soft and somewhat gelatinous when soaked in water'. We, however, did not observe this in *Engleromyces* collections from Kenya; on immersion in water the flesh absorbs water assuming the consistency of a firm bathroom sponge. It was not gelatinous. We consider Kokwaro's (1983) description of the flesh as like a heavy cake resembling the local millet bread 'ugali' as very apt. Thus *Engleromyces* clearly differs from *Entonaema* whose dried stromata readily take up water when submerged and become inflated and gelatinous again.

Discussion

Lloyd (1917) referred to *Engleromyces goetzei* as the largest pyrenomycete. Certainly collections from Africa justify this statement. Kokwaro (1983) stated that 'it is a semi-solid structure which can grow to the size of a football and weigh up to 4 kg. Its Kikuyu name 'Kieha-kia-Murangi' means 'that which sits on bamboo' and it is found only on the upper stems of the mountain bamboo *Arundinaria alpina* K. Schum. It partially envelopes the bamboo stem, often forming two lobes, hence its English name. 'baby's bottom' (Kokwaro, 1983). In a letter to Dr D.A. Reid at Kew on 3 June 1961, Mr I.A.S. Gibson, Forest Pathologist (Kenya), wrote 'I still cannot see where it gets its nutrient from to form such an enormous fruit body. One of the larger ones we have weighed at 4.5 kilos fresh and it was by no means all water!'. The collections from Yunnan that we examined are considerably smaller attaining a size of only 5.5 cm., which is in agreement with Teng (1996) (5–6 cm in the dried state), although Ying &

Zang (1994) recorded up to 20 cm diameter. Two of our authors, YJY and TZW, have seen specimens of *E. sinensis* larger than the holotype commonly for sale on market stalls in Yunnan.

Although possessing many of the features of *E. goetzei*, *E. sinensis* differs in a number of important characters. The ascospore dimensions are considerably smaller than those of the African collections and do not have the citriform to C-shape of the African material. The apical apparatus is also quite different, being T-shaped or resembling a golf-tee, totally unlike the cuboid apical apparatus found in the African collections. We were unable to observe a germ pore on the ascospores by scanning electron microscopy as spores were shrouded in the remains of the ascus, but we were able to observe appendages on at least one end of the ascospores by light microscopy. However, the ascospores were not in good condition, a problem also encountered by Rogers (1981) and Teng (1996). We found no evidence that the asci of the Kenyan or Chinese material deliquesced at maturity.

The host for both species of *Engleromyces* was recorded as *Arundinaria* in both Africa and China. The African species of bamboo has since been reclassified as *Yushania alpina* (K. Schum.) W.C. Lin and the bamboo from Yulong mountain in Yunnan is now referred to either *Fargesia melanostachys* (Hand.-Mazz.) T.P. Yi or *Fargesia yulongshanensis* T.P. Yi (Professor Nianhe Xia, pers. com.).

Engleromyces goetzei from Kenya has been the subject of chemical analysis and was found to contain a new cytochalasin, engleromycin (Pedersen et al. 1980). Interestingly, *E. goetzei* has been used in traditional African medicine for the treatment of a number of ailments including fever associated with malaria (Kokwaro, 1983). Cytochalasins are produced by many xylariaceous fungi, especially species of *Xylaria* Hill ex Schrank, *Rosellinia* De Not. and *Nemania* Gray (Whalley 1996, Whalley & Edwards 1995). The medicinal uses of *E. sinensis* in China have been recorded mostly under the name *E. goetzei* [as “*goetzii*”]. The fungus has long been used for treating illnesses and has anti-inflammatory and anti-microbial properties (Ying et al. 1987). A study of secondary metabolites from *Engleromyces* from Yunnan revealed a novel compound, neoengleromycin (Liu et al. 2002). These authors also refer to the folk-use of this fungus against infectious diseases and cancer in Tibet, Yunnan, and Sichuan Provinces. The cytochalasins are known to inhibit cell division (Betina 1989) and the link to treatment of cancer is therefore very interesting.

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Literature cited

- Betina V. 1989. Mycotoxins: chemical, biological and environmental aspects. Elsevier: Amsterdam.
- Dennis RWG. 1961. *Xylarioideae* and *Thamnomycetoideae* of Congo. Bulletin Jardin Botanique de l'Etat (Bruxelles) 31: 109–154.
- Hennings P. 1900. Fungi Africae orientalis. Engler's botanisheucher fur Systematik, Pflanzengeschichte und Pflanzengeographie 28: 318–529.
- Kokwaro JO. 1983. An African knowledge of ethnosystematics and its application to traditional medicine, with particular reference to the medicinal use of the fungus *Engleromyces goetzei*. Bothalia 14: 237–243.
- Liu J-K, Tan J-W, Dong Z-J, Ding Z-H, Wang X-H, Liu P-G. 2002. Neoengleromyces, a novel compound from *Engleromyces goetzii*. Helvetica Chimica Acta 85: 1439–1442.
- Lloyd CG. 1917. Synopsis of some genera of the large pyrenomycetes. *Camillea. Thamnomycetes. Engleromyces*. Cincinnati OH. 16 p.
- Mao X-L. 1998. Economic fungi of China. Beijing: Science Press.
- Mao X-L. 2000. The macrofungi in China. Henan Science and Technology Press, Zhengzhou, China.
- Mao, X-L, Jiang, C-P, Ouzhuciwang. 1993. Economic macrofungi of Tibet. Beijing: Beijing Science and Technology Press.
- Müller E, von Arx JA. 1975. *Pyrenomycetes: Melioliales, Coronophorales, Sphaeriales*. In *The Fungi: an advanced treatise* Vol. 4A. (Eds. GC Ainsworth, FK Sparrow, AS Sussman). Pp. 87–132. Academic Press. New York.
- Pedersen EJ, Larsen P, Boll PM. 1980. Engleromycin, a new cytochalasin from *Engleromyces goetzii* Hennings. Tetrahedron Letters 21: 5079–5082.
- Rogers JD. 1981. *Sarcoxydon* and *Entonaema* (*Xylariaceae*). Mycologia 73: 28–61.
- Saccardo PA. 1902. Sylloge Fungorum. Vol. 22 (1). Patavii. 822 p.
- Teng S-C. 1996. Fungi of China. Mycotaxon Ltd., Ithaca, New York.
- von Arx JA, Müller E. 1954. Die Gattungen der amersporen Pyrenomyceten. Beitr. Kryptogamenflora Schweiz 11: 1–434.
- Whalley AJS. 1996. The xylariaceous way of life. Mycological Research 100: 897–922.
- Whalley AJS, Edwards RL. 1995. Secondary metabolites and taxonomic arrangement within the *Xylariaceae*. Canadian Journal of Botany 73(Supplement 1): S802–S810.
- Ying J-Z, Mao X-L, Ma Q-M, Zong Y-C, Wen H-A. 1987. Icones of Medicinal Fungi from China. Beijing: Science Press.
- Ying J-Z, Zang M. 1994. Economic macrofungi from southwestern China. Beijing: Science Press (in Chinese).
- Yuan M-S, Sun P-Q. 1995. Sichuan mushrooms. Chengdu, China: Sichuan Sciences and Technology Press. (in Chinese).

Two new *Taifanglania* species identified through DELTA-assisted phenetic analysis

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Abstract — Two new species isolated from soil samples from Mianyang City, Sichuan Province and Nantong City, Jiangsu Province, China, were revealed through classical morphology and DELTA-assisted analyses. Both species are described and illustrated and diagnostic characters revealed through DELTA are discussed. *Taifanglania berberidis* is characterized by brown colony, black reverse, phialides $7.2\text{--}13.5 \times 1.8\text{--}4.2\ \mu\text{m}$, with an ellipsoidal swollen basal portion and fusiform conidia, $4.8\text{--}9.0 \times 1.8\text{--}3.0\ \mu\text{m}$; *T. jiangsuensis* is distinguished by yellow colony, rough or smooth-walled hyphae, phialides $6\text{--}15 \times 1.8\text{--}3.0\ \mu\text{m}$, with a cylindrical swollen basal portion and ellipsoidal or fusiform conidia, $3.6\text{--}6 \times 2.4\text{--}3.0\ \mu\text{m}$, forming chains and often capitate at the top.

Key words — thermotolerant fungi, morphological character, numerical classification

Introduction

The genus *Taifanglania* was established by Liang et al. (2009), who selected *T. hechuanensis* as the type species and accepted nine species in the genus worldwide. *Taifanglania* species are thermophilic fungi that play an important role in cellulose degradation of compost, garbage, and straw (Liang et al. 2007; Kluczek-Turpeinen et al. 2003, 2007; Kluczek-Turpeinen 2007). In addition, they can produce novel active substances (Hill & Pitt 1999) and useful thermophilic enzymes such as laccases (Liang et al. 2007, 2009; Yang et al. 2006).

The recent use of molecular data in systematic analyses has enabled the identification of many new fungi (Luangsa-ard et al. 2004, 2005; Rehner & Buckley 2005; Sung et al. 2007). However, as noted by Hawksworth (2004), only about 11.5% of the known species were represented among the fungal sequences present in Genbank in 2004 and of those, regrettably approximately one-fifth was incorrectly identified. In addition, Paterson (2007, 2008) has

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reported that mycotoxins present in some cultures may adversely affect DNA sequence analysis. For these reasons, many researchers use polyphasic taxonomy based on molecular, morphological, numerical approaches and physiological data (Houbraken et al. 2007; Samson et al. 2007; Varga et al. 2007a,b). In this regard, the DELTA expert morphology-based system offers many advantages to the classical taxonomic research of animal, plant and microbes that permit digital standardization of morphological characters to make them suitable for taxonomic identification (Carney 2003; Chang et al. 2000; Chen & Chen 2008; Li et al. 1993; Li 1996) and international communication (Chen & Kuoh 2000a,b; Han et al. 2009). In this paper we report and illustrate two new *Taifanglania* species, *T. berberidis* and *T. jiangsuensis*, that were identified using classical morphology in the DELTA system.

Materials and methods

MATERIALS—The eleven *Taifanglania* species used in the study are listed in TABLE 1.

SAMPLE COLLECTION AND STRAIN ISOLATION — Strain GZUIFR-SGQH346 and GZUIFR-HC48.1 were isolated from soil samples of Mianyang City, Sichuan Province and Nantong City, Jiangsu Province, China, respectively. Two grams of soil were added to a flask containing 20 ml sterilized water and glass beads. Each soil suspension was shaken for about 10 min. and then diluted to concentrations of 10⁻¹–10⁻². One ml suspension (10⁻²) was mixed with Martin medium in a sterilized Petri dish of 9 cm diam. Cultures were incubated at 40°C for 14 days.

STRAIN IDENTIFICATION — The strains were transferred to Czapek agar. After incubation at 40°C for 7 days, the strains were identified based on colony characters and conidiogenous structures according to Liang et al. (2009).

TABLE 1. List of *Taifanglania* spp. for constructing DELTA database

No.	NAMES	REFERENCES
1	<i>T. ampullaris</i> (Matsush.) Z.Q. Liang et al.	Matsushima 1971, Liang 2009
2	<i>T. ampulliphora</i> (Matsush.) Z.Q. Liang et al.	Matsushima 1975, Liang et al. 2009
3	<i>T. biformis</i> (Z.Q. Liang et al.) Z.Q. Liang et al.	Liang et al. 2007, 2009
4	<i>T. cinerea</i> (Z.Q. Liang et al.) Z.Q. Liang et al.	Liang et al. 2006, 2009
5	<i>T. curticatenata</i> (Z.Q. Liang & Y.F. Han) Z.Q. Liang et al.	Han et al. 2007, Liang et al. 2009
6	<i>T. furcata</i> (Z.Q. Liang et al.) Z.Q. Liang et al.	Liang et al. 2006, 2009
7	<i>T. hechuanensis</i> Z.Q. Liang et al.	Liang et al. 2002, 2009
8	<i>T. inflata</i> (Burnside) Z.Q. Liang et al.	Samson 1974, Liang et al. 2009
9	<i>T. major</i> (Z.Q. Liang et al.) Z.Q. Liang et al.	Chu et al. 2004, Liang et al. 2009
10	<i>T. berberidis</i>	(this work)
11	<i>T. jiangsuensis</i>	(this work)

TABLE 2. Characters and character states in *Taifanglania*

#1. Note/	#10. Phialides length/μm/
#2. Colony/	#11. Phialides width/μm/
#3. Colony color/ 1. Pale yellow/ 2. Pale-brown/ 3. Gray/ 4. White/ 5. Yellow/	#12. Phialides <shape>/ 1. cylindric/ 2. ovoid/ 3. ellipsoid/ 4. subglobose/ 5. fusiform/
#4. Reverse color/ 1. Yellow/ 2. Dark/ 3. Offwhite/	#13. Conidia surface/ 1. tiny rough/ 2. smooth/
#5. Colony texture/ 1. Compact velvety/ 2. Velvety, powdery or floccose to funiculose/ 3. Short floccose/ 4. Loose velvety/	#14. Conidia <shape>/ 1. ellipsoid/ 2. subglobose/ 3. cylindric/ 4. ovate/ 5. obovoid/ 6. fusiform/ 7. Lemon-shaped/
#6. Vegetative hyhpae <width μm>/	#15. Conidia width/μm/
#7. Hyhpae surface/ 1. tiny rough/ 2. smooth/	#16. Conidia length/μm/
#8. Conidiophore/ 1. present (simple) 2. lacking/	#17. Conidial chain/ 1. long/ 2. short/
#9. Phialides/	#18. Inhabit/ soil/

THE PHENETIC TREE GENERATED BY DELTA SYSTEM —Diagnostic characters and character states from the selected *Taifanglania* strains were entered into DELTA system as described by Han et al. (2009) to form the database (TABLE 2). According to the program CONFOR with the “todis” directives of Editor, the phenetic tree was generated by DELTA system using the PCLASS program.

New species

Taifanglania berberidis Y.F. Han & Z.Q. Liang, sp. nov. FIG. 1

MYCOBANK MB 516503

In agaro Czapekii, coloniae 75–80 mm diam., 14 diebus ad 40°C, planae, brunnea. *Conidiophora absentia*. *Phialides singulares*, 7.2–13.5 × 1.8–4.2 μm, e basi inflata ellipsoidea in collum distinctum apice inspissato angustatae. *Conidia fusiformia*, 4.8–9.0 × 1.8–3.0 μm, catenata, interdum et capitata ad extremam.

Holotypus GZUIFR-SGQH346 isolatus, e soli, Mianyang City, Provincia Sichuan, China. VIII, 2006, Y.F.HAN, in Guizhou Univ, conservatur.

ETYMOLOGY: *berberidis* (Latin), referring to the associated plant genus.

COLONY on Czapek agar reaching 75–80 mm diam. within 14 days at 40°C, flat, felty, with brown center and gray margin, irregularly radially grooved, faintly wavy at the margin. Reverse black. VEGETATIVE HYPHAE hyaline, smooth-walled, 1.2–3.0 µm in diam. PHIALIDES single, borne directly on the vegetative hyphae, 7.2–13.5 × 1.8–4.2 µm, with an ellipsoidal swollen basal portion, tapering into a distinct neck. CONIDIA hyaline, smooth-walled, fusiform, 4.8–9.0 × 1.8–3.0 µm, forming chains and sometimes capitate at the top.

DISTRIBUTION: Sichuan Province, China.

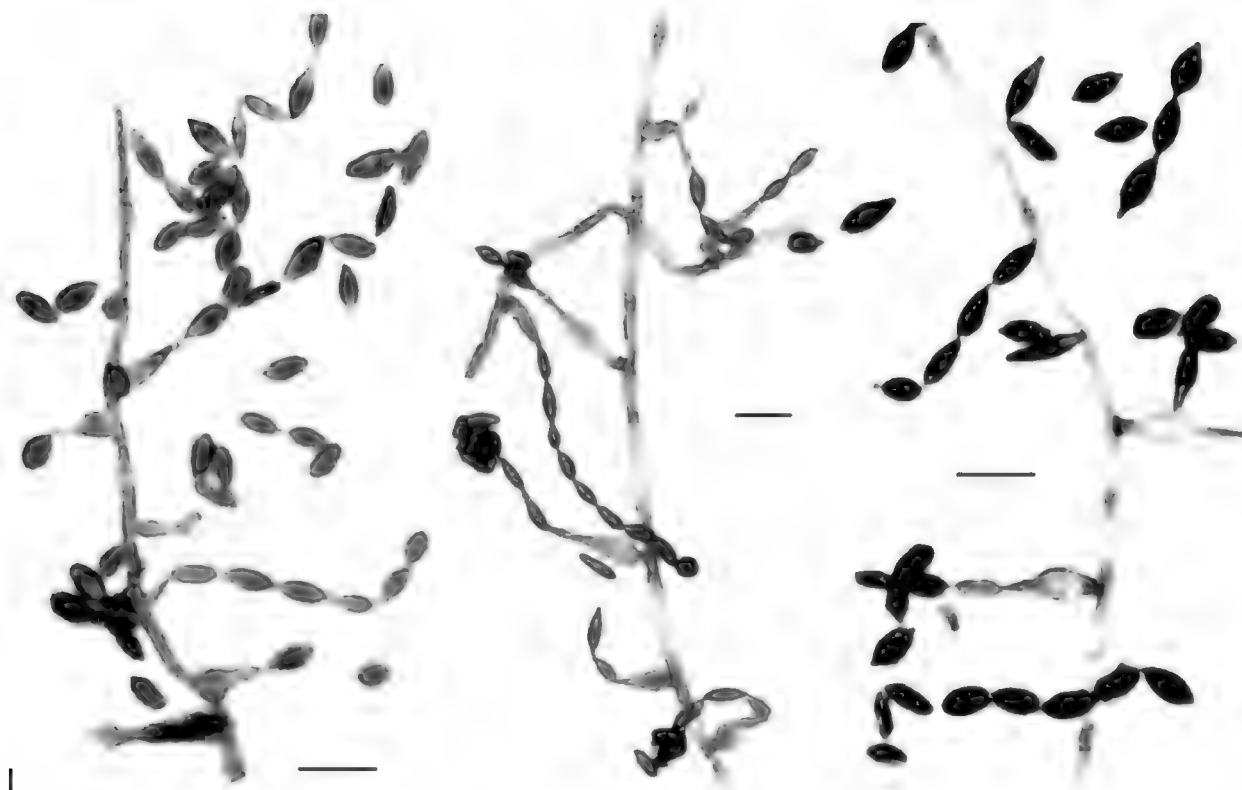


FIG. 1. Conidiogenous structures of *Taifanglania berberidis*. Bars = 10 µm

COMMENTS: Other *Taifanglania* species characterized by fusiform conidia are *T. inflata*, *T. jiangsuensis*, *T. hechuanensis*, and *T. biformis*. The following characters separate those species from *T. berberidis*: *T. inflata* is mesophilic, *T. jiangsuensis* colonies are yellow, the reverse of *T. hechuanensis* colonies is gray, and *T. biformis* has an echinate conidiophore. *Taifanglania berberidis* can be distinguished by its thermophilic character, brown colony with the black reverse, single phialides, and often capitate top of conidial chain.

***Taifanglania jiangsuensis* Y.F. Han & Z.Q. Liang, sp. nov.**

FIG. 2

MYCOBANK MB 516504

In agaro Czapekii, coloniae 45–50 mm diam., 14 diebus ad 40°C, villiformis, flava. Conidiophora absentia. Phialides singulares, 6–15 × 1.8–3.0 µm, e basi inflata cylindrica in collum distinctum apice inspissato angustatae. Conidia ellipsoidea vel fusiformia, 3.6–6 × 2.4–3.0 µm, catenata, saepe et capitata ad extremam.

Holotypus GZUIFR-HC48.1 isolatus, *e soli*, Nantong City, Provincia Jiangsu, China. IV, 2005, Y.F.HAN, in Guizhou Univ, conservatur.

ETYMOLOGY: *jiangsuensis* (Latin), referring to Jiangsu Province, where the type locality is situated.

COLONY on Czapek agar reaching 45–50 mm diam. within 14 days at 40°C, villiform, light yellow. Reverse yellow. VEGETATIVE HYPHAE hyaline, rough or smooth-walled, 0.6–1.2 μm diam. PHIALIDES single, sometimes proliferating, borne directly on the vegetative hyphae, 6–15 \times 1.8–3.0 μm , with a cylindrical swollen basal portion, tapering into a distinct neck. CONIDIA hyaline, smooth-walled, ellipsoidal or fusiform, 3.6–6 \times 2.4–3.0 μm , forming chains, often capitate at the top.

DISTRIBUTION: Jiangsu Province, China.



FIG. 2. Conidiogenous structures of *Taifanglania jiangsuensis*. Bars = 10 μm

COMMENTS: Other *Taifanglania* species that produce light colonies on Czapek agar are *T. inflata* and *T. ampullaris*. *T. jiangsuensis*. The fact that *T. inflata* is mesophilic and *T. ampullaris* produces smaller conidia ($2.2\text{--}3.4 \times 2\text{--}2.6 \mu\text{m}$) differentiate those species from *T. jiangsuensis*. Additionally *T. jiangsuensis* may possess either smooth or rough hyphae.

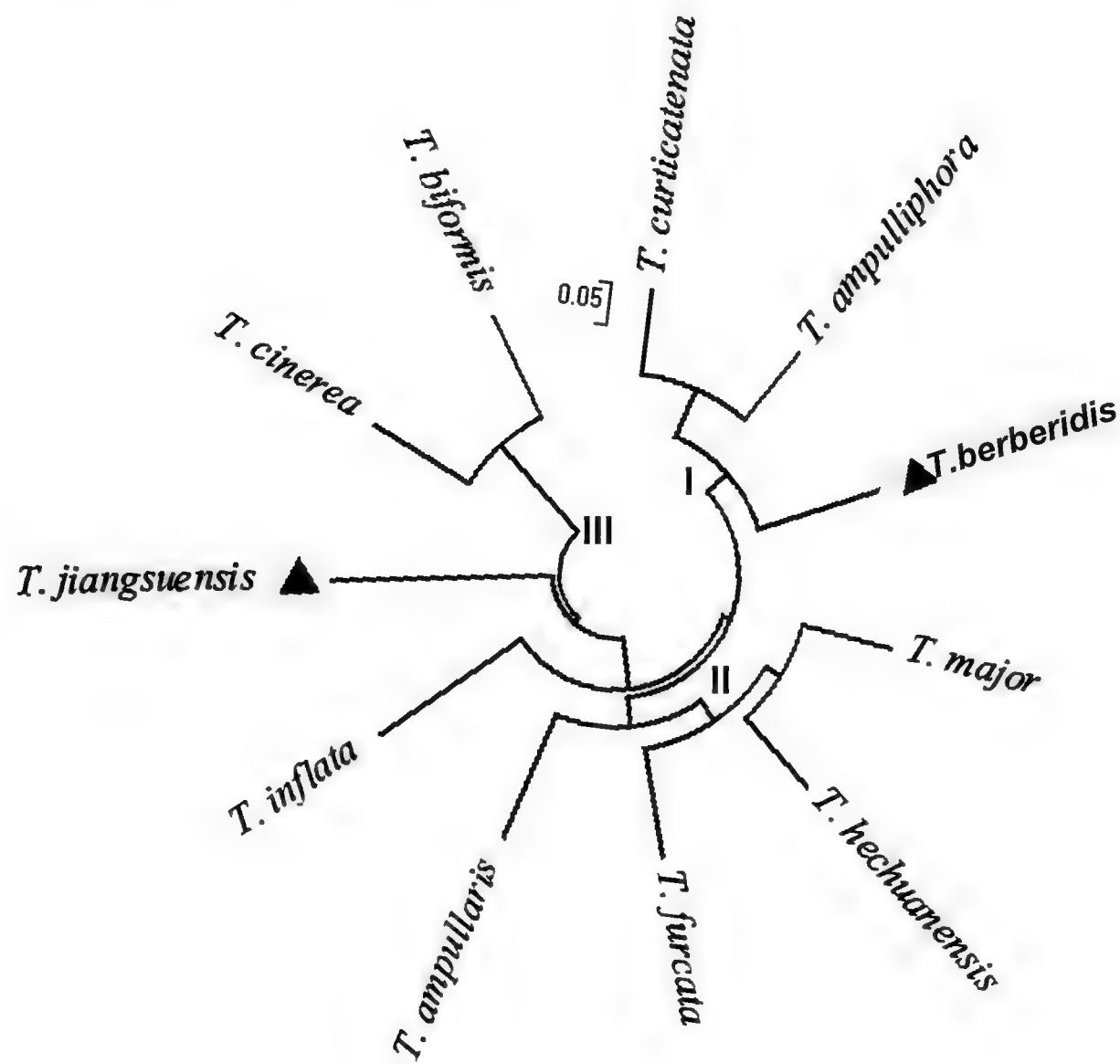


FIG. 3. Phenetic tree generated for *Taifanglania* spp. by DELTA.

Numerical taxonomy

Numerical character classification was not granted special priority, so that all characters selected were weighted equally in this study. The phenetic tree based on the morphological characteristics is presented in FIGURE 3, which separates *T. jiangsuensis* and *T. inflata* from each other and from all other *Taifanglania* species. The remaining species fall into three distinct groups (I–III).

Group I species (i.e., *T. curticatenata*, *T. ampulliphora*, *T. berberidis*) all produce brown colonies on Czapek agar. Both *T. curticatenata* and *T.*

ampulliphora are characterized by rough conidia (Han et al. 2007, Matushima 1975), separating them from *T. berberidis*, which produces smooth, fusiform conidia, which supports *T. berberidis* as an independent species.

Group II species (i.e., *T. major*, *T. hechuanensis*, *T. furcata*, *T. ampullaris*) share light colony color and phialides with ellipsoidal basal portions.

Group III includes *T. cinerea* and *T. biformis*, whose common characters are the villiform colony and conidia that are fusiform, ellipsoidal to cylindrical, and longer than 13 μm . Within the group, the unique biform conidiogenous structures separate *T. biformis* from *T. cinerea* (Liang et al. 2006, 2007).

The new species *T. jiangsuensis*, which stands on an independent branch, can be characterized by its yellow villiform colony, yellow reverse, and tiny rough hyphae.

The phenetic tree generated from morphological characters observed in the eleven *Taifanglania* species using the INTKEY program of DELTA system showed that colony color, colony texture, shape of conidia, reverse color, and conidial length are diagnostic for the identification of *Taifanglania* species.

In conclusion, *T. berberidis* and *T. jiangsuensis* are two new distinctive taxa with the support derived from morphology with the phenetic analysis of DELTA system.

Acknowledgements

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References

- Carney RS. 2003. Preparation of an interactive key for the northern Gulf of Mexico polychaete taxonomy employing the DELTA/INTKEY system. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS, New Orleans La. OCS Study MMS 2003-065: 38.
- Chang ER, Dickinson TA, Jefferies RL. 2000. Seed flora of La Pérouse Bay, Manitoba, Canada: a DELTA database of morphological and ecological characters. Canadian Journal of Botany 78: 481–496.
- Chen CHK, Kuoh CS. 2000a. The application of DELTA database system on taxonomy. Quarterly Journal of Chinese Forestry 33: 573–583.
- Chen CHK, Kuoh CS. 2000b. The genus *Bromus* L. (Poaceae) in Taiwan: A DELTA database for generating key and descriptions. Taiwania 45: 311–322.
- Chen X, Chen X. 2008. Application of new DELTA system in plant taxonomy — Study on *Festuca* L. as an example. Guihaia 28: 759–763.
- Chu HL, Liang ZQ, Han YF. 2004. A thermotolerant *Paecilomyces inflatus* var. *major* Liang Z.Q., Chu H.L., Han Y.F. var. nov. which produces laccase. Journal of Fungal Research 2(3): 43–46.
- Han YF, Liang ZQ, Chu HL. 2007. A new thermophilic species of *Paecilomyces*, *Paecilomyces curticaenatus*. Mycosystema 26(1): 13–16.

- Han YF, Zhang YW, Liang JD, Liang ZQ. 2009. Studies on the genus *Paecilomyces* in China. Application of DELTA expert system on the entomopathogenic *Paecilomyces* sensu lato. *Mycotaxon* 109: 75–84.
- Hawksworth DL. 2004. Fungal diversity and its implications for genetic resource collections. *Studies in Mycology* 50: 9–17.
- Hill RA, Pitt AR. 1999. Hot off the press. *Natural Product Reports* 16: 3–6.
- Houbraken JM, Varga J, Meijer M, Frisvad JC, Samson RA. 2007. Polyphasic taxonomy of *Aspergillus* section *Usti*. *Studies in Mycology* 59: 107–128.
- Kluczek-Turpeinen B. 2007. Lignocellulose degradation and humus modification by the fungus *Paecilomyces inflatus*. Academic Dissertation in Microbiology, Division of Microbiology Department of Applied Chemistry and Microbiology University of Helsinki. Helsinki 1–84.
- Kluczek-Turpeinen B, Maijala P, Hofrichter M, Hatakka A. 2007. Degradation and enzymatic activities of three *Paecilomyces inflatus* strains grown on diverse lignocellulosic substrates. *International Biodeterioration & Biodegradation* 59 (4): 283–291.
- Kluczek-Turpeinen B, Tuomela M, Hatakka A, Hofrichter M. 2003. Lignin degradation in a compost environment by the deuteromycete *Paecilomyces inflatus*. *Applied Microbiology and Biotechnology* 61: 374–379.
- Li DC, Zhang TY, Wu JS. 1993. A preliminary study of numerical taxonomy of the genus *Alternaria* (*Hyphomycetes*). *Acta Mycologica Sinica* 12: 232–239.
- Li JJ. 1996. DELTA system-the international standard for plant taxonomy description language. *Act. Phyto. Sin.* 34: 447–452.
- Liang ZQ, Han YF, Chu HL. 2006. Studies on the genus *Paecilomyces* in China. IV. Two new species of *Paecilomyces* with monophialides. *Mycotaxon* 97: 13–20.
- Liang ZQ, Han YF, Chu HL. 2007. A new thermotolerant *Paecilomyces* species which produces laccase and a biform sporogenous structure. *Fungal Diversity* 27: 95–102.
- Liang ZQ, Han YF, Chu HL, Fox RTV. 2009. Studies on the genus *Paecilomyces* in China V. *Taifanglania* gen. nov. for some monophialidic species. *Fungal Diversity* 34: 69–77.
- Luangsa-ard JJ, Hywel-Jones NL, Samson RA. 2004. The polyphyletic nature of *Paecilomyces* sensu lato based on 18S-generated rDNA phylogeny. *Mycologia* 96:773–780.
- Luangsa-ard JJ, Hywel-Jones NL, Manoch L, Samson RA. 2005. On the relationships of *Paecilomyces* sect. *Isarioidea* species. *Mycological Research* 109:581–589.
- Matushima T. 1971. Microfungi of the Solomon Islands and Papua-New Guinea. Published by the Author, Kobe: 42.
- Matushima T. 1975. Icones Microfungorum a Matushima Lectorum. Published by the Author, Kobe: 104.
- Paterson RRM. 2007. Internal amplification controls have not been employed in fungal PCR hence potential false negative results. *Journal of Applied Microbiology* 102: 1–10.
- Paterson RRM. 2008. Fungal Enzyme Inhibitors as Pharmaceuticals, Toxins and Scourge of PCR. *Current Enzyme Inhibition* 4: 46–59.
- Rehner SA, Buckley E. 2005. A *Beauveria* phylogeny inferred from nuclear ITS and EF1-a sequences: evidence for cryptic diversification and links to *Cordyceps* teleomorphs. *Mycologia* 97(1): 84–98.
- Samson RA. 1974. *Paecilomyces* and some allied hyphomycetes. *Studies in Mycology* 6: 1–119.
- Samson RA, Hong S, Peterson SW, Frisvad JC, Varga J. 2007. Polyphasic taxonomy of *Aspergillus* section *Fumigati* and its teleomorph *Neosartorya*. *Studies in Mycology* 59: 147–203.
- Sung GH, Hywel-Jones NL, Sung JM, Luangsa-ard JJ, Shrestha B, Spatafora JW. 2007. Phylogenetic classification of *Cordyceps* and the clavicipitaceous fungi. *Studies in Mycology* 57: 5–59.

- Varga J, Due M, Frisvad JC, Samson RA. 2007a. Taxonomic revision of *Aspergillus* section Clavati based on molecular, morphological and physiological data. *Studies in Mycology* 59: 89–106.
- Varga J, Frisvad JC, Samson RA. 2007b. Polyphasic taxonomy of *Aspergillus* section Candidi based on molecular, morphological and physiological data. *Studies in Mycology* 59: 75–88.
- Yang SQ, Yan QJ, Jiang ZQ, Li LT, Tian HM, Wang YZ. 2006. High-level of xylanase production by the thermophilic *Paecilomyces thermophila* J18 on wheat straw in solid-state fermentation. *Bioresource Technology* 97: 1794–1800.

Additions to the knowledge of aphyllophoroid fungi (*Basidiomycota*) of Atlantic Rain Forest in São Paulo State, Brazil

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Abstract — The list of aphyllophoroid fungi of the Atlantic Rain Forest in the state of São Paulo is updated. Specimens were collected in four different areas of the Atlantic Rain Forest from 1988 to 2007. Exsiccates deposited in the Herbarium SP were also studied. A list of 85 species of *Basidiomycota* distributed into 11 families and four orders (*Agaricales*, *Hymenochaetales*, *Polyporales*, *Russulales*) is presented. All species are mentioned for the first time for the collection sites. Two species are reported for the first time for Brazil and 17 species are recorded for the first time for São Paulo State. The complete list of specimens is available at <http://www.mycotaxon.com/resources/weblists.html>.

Key words — diversity, macrofungi, neotropics, taxonomy

Introduction

The Atlantic Rain Forest, which has 20,000 species of plants of which 6000 are endemic, is the second largest block of tropical forests of Brazil. This biome, which formerly occupied 1,315,460 km² of Brazilian territory, extending through the region from Osório, Rio Grande do Sul State (29°53'S and 50°16'W) to Cabo de São Roque, Rio Grande do Norte State (05°31'S and 35°16'W), holds today less than 8% of its original extent and has become one the world's top five biological hotspots (Mittermeier et al. 1999, SOS Mata Atlântica/INPE 2009).

The state of São Paulo still holds a significant portion of this important biome (15% of the total remaining forest), largely in protected areas (Secretaria

do Estado de Meio Ambiente 1996, 2000, SOS Mata Atlântica/INPE 2009). It includes several types of tropical ecosystems, such as the coasts of the Atlantic Ocean, the forests of lowlands and slopes of the Serra do Mar, inland forests and woods of *Araucaria* (Secretaria de Estado do Meio Ambiente 1996).

The aim of this study is to contribute to the knowledge of the diversity of aphyllorphoroid fungi of the Atlantic Forest and the state of São Paulo, complementing the inventories in the Parque Estadual da Ilha do Cardoso (Bononi 1979a,b,c, 1984, Gugliotta & Capelari 1995, Gugliotta & Bononi 1999) and Parque Estadual das Fontes do Ipiranga (Bononi et al. 1981, Jesus 1993, Soares & Gugliotta 1998, Louza & Gugliotta 2007, Leal & Gugliotta 2008), and expanding the checklist for aphyllorphoroid fungi cited from the Brazilian Atlantic Forest by Baltazar & Gibertoni (2009).

Materials and methods

Specimens were collected in four different areas of the Atlantic Rain Forest in the State of São Paulo, from 1988 to 2007:

1. Parque Estadual da Ilha do Cardoso (25°03'S–48°05'W, 22,500 ha), municipality of Cananéia;
2. Reserva Biológica de Paranapiacaba (23°46'S–46°18'W, 336 ha), municipality of Santo André;
3. Parque Estadual das Fontes do Ipiranga (23°39'S–46°37'W, 549.31 ha), municipality of São Paulo;
4. Reserva Florestal da Cidade Universitária “Armando de Salles Oliveira” da Universidade de São Paulo (23°33'S–46°43'W, 10 ha), municipality of São Paulo.

The studied material was deposited in SP herbarium (Holmgren & Holmgren 1998). Exsiccates from these localities deposited in the Herbarium SP were also studied. Micromorphological observations were made from material mounted in 5% KOH and Melzer's reagent; measurements were made in 5% KOH. Nomenclature, taxonomy and author citation followed databases: CBS (<http://www.cbs.knaw.nl/databases/>) and Index Fungorum (<http://www.indexfungorum.org/Names/Names.asp>).

Results and discussion

A list of 85 species of *Basidiomycota* distributed into 11 families and four orders (*Agaricales*, *Hymenochaetales*, *Polyporales*, *Russulales*) is presented. *Polyporaceae* is the most represented family with 30 species. All species are mentioned for the first time for the collection sites.

Schizopora trichiliae (Van der Byl) Ryvarden and *Porogramme albocincta* (Cooke & Masee) J. Lowe are recorded for the first time for Brazil.

Seventeen of the identified species are recorded for the first time for São Paulo State: *Amauroderma omphalodes* (Berk.) Torrend, *Coltricia cinnamomea* (Jacq.) Murrill, *Daedalea aethalodes* (Mont.) Rajchenb., *Dichochaete setosa* (Sw.) Parmasto, *Echinoporia aculeifera* (Berk. & M.A. Curtis) Ryvarden, *Henningsia brasiliensis* (Speg.) Speg., *Hymenochaete floridea* Berk. & Broome, *Hymenochaete minuscula* G. Cunn., *Hymenochaete pinnatifida* Burt, *Hymenochaete rubiginosa* (Dicks.) Lév., *Megasporoporia setulosa* (Henn.) Rajchenb., *Nigroporus macroporus* Ryvarden & Iturr., *Perenniporia ohiensis* (Berk.) Ryvarden, *Perenniporia piperis* (Rick) Rajchenb., *Phellinus ferrugineovelutinus* (Henn.) Ryvarden, *Tinctoporellus epimiltinus* (Berk. & Broome) Ryvarden and *Tyromyces fumidiceps* G.F. Atk.

Gugliotta & Capelari (1995) and Gugliotta & Bononi (1999) reported the occurrence of *Trametes versicolor* (L.) Lloyd in Parque Estadual da Ilha do Cardoso, Municipality of Cananéia, but the specimen (SP 193613) was examined later and re-identified as *Coriolopsis caperata* (Berk.) Murrill; the occurrence of *T. versicolor* in this area was not confirmed.

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Literature cited

- Baltazar JM, Gibertoni TB. 2009. A checklist of the aphyllorphoroid fungi (*Basidiomycota*) recorded from the Brazilian Atlantic rain forest. *Mycotaxon* 109: 493–442.
- Bononi VL. 1979a. Basidiomicetos do Parque Estadual da Ilha do Cardoso: I. Espécies hidnóides. *Rickia* 8: 63–74.
- Bononi VL. 1979b. Basidiomicetos do Parque Estadual da Ilha do Cardoso: II. *Hymenochaetaceae*. *Rickia* 8: 85–99.
- Bononi VL. 1979c. Basidiomicetos do Parque Estadual da Ilha do Cardoso: III. Espécies clavarióides, teleforóides e estereóides. *Rickia* 8: 105–121.
- Bononi VL. 1984. Basidiomicetos do Parque Estadual da Ilha do Cardoso. IV. Adições às famílias *Hymenochaetaceae*, *Stereaceae* e *Thelephoraceae*. *Rickia* 11: 43–52.
- Bononi VLR, Trufem SFB, Grandi RAP. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil, depositados no herbário do Instituto de Botânica. *Rickia* 9: 37–53.
- Gugliotta A, Bononi VLR. 1999. *Polyporaceae* do Parque Estadual da Ilha do Cardoso, São Paulo, Brasil. *Bol. Inst. Bot. (São Paulo)* 12: 1–112.
- Gugliotta A, Capelari M. 1995. *Polyporaceae* from Ilha do Cardoso, SP, Brazil. *Mycotaxon* 56: 107–113.
- Holmgren PK, Holmgren NH. 1998. Index Herbariorum: New York Botanical Garden's Virtual Herbarium. Available at: <http://sweetgum.nybg.org/ih/Holmgren>.
- Jesus MA. 1993. Basidiomicetos lignocelulolíticos de floresta nativa e de *Pinus elliottii* Engelm. do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. *Hoehnea* 20(1/2): 119–126.

- Leal GR, Gugliotta AM. 2008. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Fungos, 9: *Meripilaceae*. Hoehnea 35(1): 99–110.
- Louza GSG, Gugliotta AM. 2007. *Polyporus* Fr. (*Polyporaceae*) no Parque Estadual das Fontes do Ipiranga, São Paulo, SP, Brasil. Hoehnea 34(3): 365–382.
- Mittermeier RA, Myers N, Gil PR, Mittermeier CG. 1999. Hotspots: earth's biologically richest and endangered terrestrial ecoregions. Mexico, CEMEX. 430 p.
- Secretaria de Estado de Meio Ambiente. 1996. Atlas das Unidades de Conservação Ambiental do Estado de São Paulo – parte I litoral. São Paulo, SMA. 30 p. + 7 mapas.
- Secretaria de Estado de Meio Ambiente. 2000. Atlas das Unidade de Conservação Ambiental do Estado de São Paulo. São Paulo, SMA. 64 p. + 19 mapas.
- Soares SCS, Gugliotta AM. 1998. Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. Fungos, 7: *Aphylllophorales* (*Hymenochaetaceae*). Hoehnea 25(1): 11–31.
- SOS Mata Atlântica, Instituto Nacional de Pesquisas Espaciais. 2009. Atlas dos remanescentes florestais da Mata Atlântica, Período 2000 a 2005. <<http://www.sosma.org.br>>.

Fungi from palms in Argentina. 1

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Abstract—Thirteen ascomycetes are reported from Argentina from fallen woody parts of three palms in two national parks. *Berkleasium corticola*, *B. sinense*, *Brachysporiella gayana*, *Dictyosporium cocophyllum*, *D. zeylanicum*, *Endocalyx melanoxanthus* var. *melanoxanthus*, *Ernakulamia cochinchensis*, *Musicillium theobromae*, *Sporidesmium macrurum*, and *Stachylidium bicolor* are new records for Argentina. *Melanochaeta hemipsila* is reported for the first time as a teleomorph in this country.

Key words—fungal taxonomy, neotropical mycobiota, pyrenomycetes

Introduction

There are nearly 2800 species of palms in the world (Blomberry & Rodd 1982), most of which are used for food, edible oils, timber, and ornamental plants (Hyde & Cannon 1999). In Argentina, there are eleven native palms, ten of which are distributed in the northeast of the country (Cabral & Castro 2007). Many Argentine palm species are found in the Atlantic Forest, a region with great biodiversity but covering only 7–8% of the national surface (Galindo-Leal & Gusmão Câmara 2003). Several areas have been proposed as natural reserves for protection of *Euterpe edulis* Mart. (“palmito”), a palm species that is currently a candidate for vulnerable status (Ministry of Ecology of the Province of Misiones).

Little is known about fungi on palms in Argentina. Spegazzini (1881) was the first to describe some of them, such as *Ceratostoma australe* [= *Cannonia australis*], a very common ascomycete on woody spathes of *Butia yatay* (Mart.) Becc., from a cultivated palm tree in Buenos Aires province. Carmona et al. (1990) described a foliar spot caused by *Pestalotiopsis palmarum* (Cooke) Steyaert on *Syagrus romanzoffiana* (Cham.) Glassman (native to Argentina). There is also published work on a foliar spot caused by *Phytophthora palmivora* (E.J. Butler) E.J. Butler, a pathogenic chromistan fungal analogue, on leaves

of *Chamaedorea elegans* Mart., a palm introduced from Mexico to Argentina (Cúndom et al. 2006).

Hyde and co-workers, who have studied fungi associated with palms from various countries, have reported and described many members of *Ascomycota* from palms (Hyde & Fröhlich 1997; Hyde et al. 1998, 2000; Fröhlich & Hyde 2000; Taylor & Hyde 2003).

In order to understand better the diversity of ascomycetes on woody parts of palms in Argentina, we studied ascomycetes on three Argentine palms — *Butia yatay*, *Euterpe edulis*, and *Syagrus romanzoffiana*. *Butia yatay* is an endangered species (Chebez 1994) and *E. edulis* is a candidate for vulnerable status (Ministry of Ecology of the Province of Misiones).

The present paper reports thirteen species from that study.

Materials and methods

The sampling area comprised two national parks: Iguazú in Misiones Province and El Palmar in Entre Ríos Province (FIG. 1).

The Iguazú national park covers an area of 67,620 hectares (25°41' S, 54°18' W) (APN 2008). This park is included in the “Paranaense province” (Cabrera & Willink 1980) of the Argentine phytogeographical regions. The climate is subtropical without a dry season. Annual rainfall averages vary between 1600 mm and 2000 mm and the annual average temperature is 20°C. The vegetation is subtropical forest, which represents the greatest animal and plant biodiversity in the country (Dirección de Bosques de Argentina 2003). The two palms studied in this area were *Syagrus romanzoffiana* and *Euterpe edulis*.

The El Palmar national park, which covers an area of 8500 hectares (31°55'S, 58°14' W), was established in 1965 with the aim of preserving *Butia yatay*, an endangered species (Chebez 1994). It is included in the Argentine phytogeographical region called “Espinal province” (Cabrera & Willink 1980). The climate is warm and humid in the north, and temperate and dry in the west and south. Rainfall ranges from 400 mm to 1500 mm, occurring mainly in spring and summer (Dirección de Bosques de Argentina 2003). The vegetation includes a savanna with palms, shrubs and gallery forest along the Uruguay river and grasslands. The palm studied here was *Butia yatay*, the only palm present in the park.

Four samplings (one per season) were carried out at each location during 2008, with a total of 825 samples gathered. Fallen rotten, woody parts, i.e. sheaths, petioles, spathes, foliar and floral rachides, were collected. The material was air-dried. Microscopic characters were observed from sporulation in vivo using light microscopy. Sizes of all the structures were based on 20 measurements. Drawings were made with a camera lucida. Photographs were taken with a Sony Digital camera. The specimens are deposited in the BAFC fungal reference collection (Holmgren et al. 1990).

The adopted classification system follows Kirk et al. (2008). For species already recorded from Argentina, brief information and references are given; new records

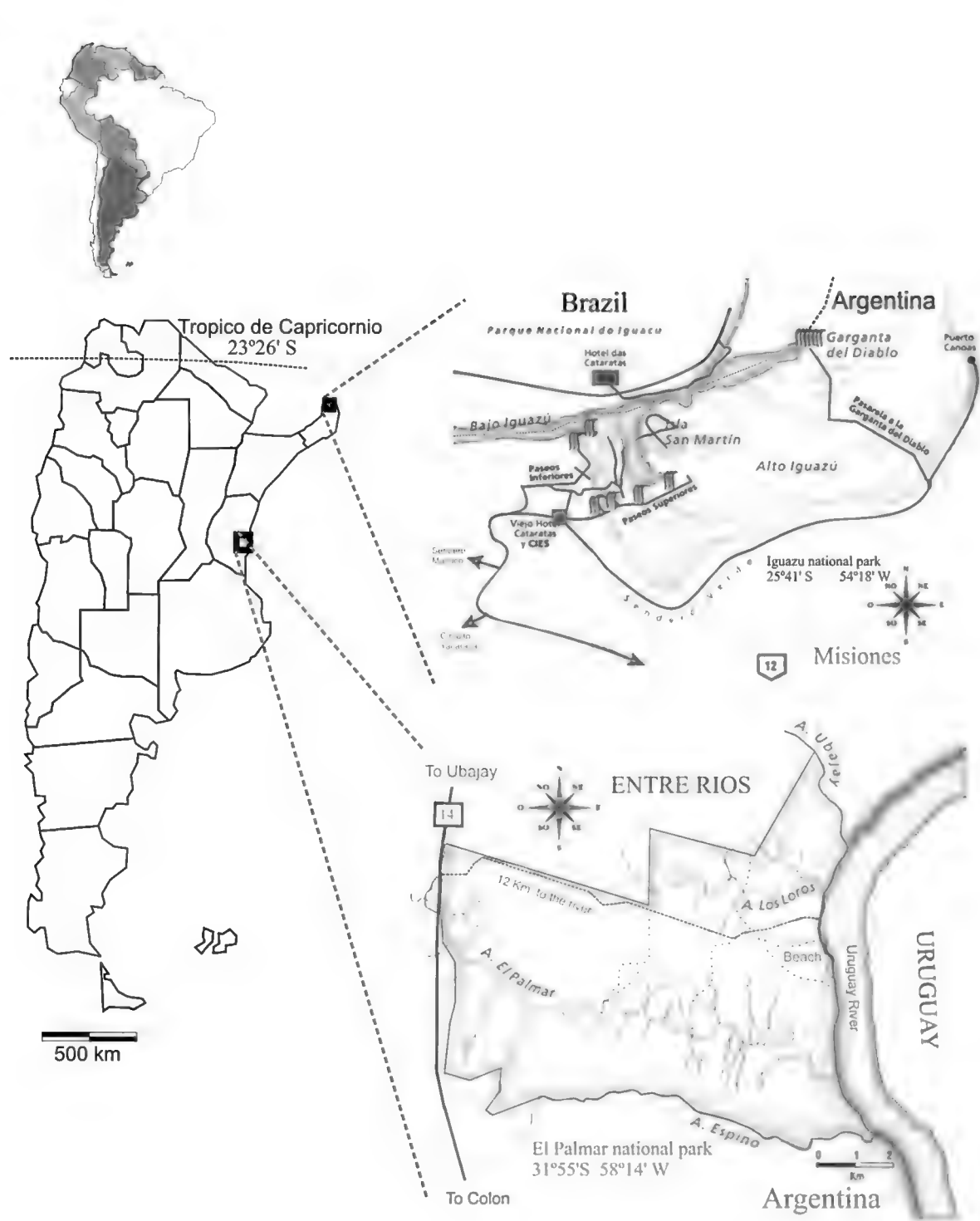


FIGURE 1 Sampling sites.

for Argentina are fully described and illustrated with information about anamorph-teleomorph relations. The type of substratum (petiole, spathe, floral rachis, etc) is given for each species.

Results

Thirteen taxa were identified, of which ten are new records for Argentina.

Cannonia australis (Speg.) Joanne E. Taylor & K.D. Hyde, Mycol. Res. 103: 1398 (1999). PL. 1 FIG. 1–3

DESCRIPTION & ILLUSTRATIONS: Taylor & Hyde (1999).

ANAMORPH — Unknown.

SUBSTRATUM — Spathe of *Syagrus romanzoffiana*. Peduncle and spathe of *Butia yatay*.

MATERIAL EXAMINED — ARGENTINA. Entre Ríos, Dpto Colón: EL PALMAR NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 23.IV.2008 (BAFC 51673). Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 22.IV.2008 (BAFC 51674).

GEOGRAPHIC DISTRIBUTION — Argentina; Australia (Taylor & Hyde 1999).

REMARKS — The collected material coincides with Taylor & Hyde's description. This species was first described in Argentina by Spegazzini (1881) as *Ceratostoma australe* on *Butia yatay*. Subsequently, Taylor & Hyde (1999) reassigned the species to the new genus *Cannonia* and described material from Argentina (on *B. yatay* from Buenos Aires) and Australia (on *Trachycarpus fortunei* H. Wendl.). This species is frequently found, mainly in the spathe and the floral rachis of *B. yatay*, at any time of year. It also occurs on spathes of *Syagrus romanzoffiana*, but in more limited areas than on *B. yatay* spathes.

Cosmospora vilior (Starbäck) Rossman & Samuels, Stud. Mycol. 42: 126 (1999). PL. 1 FIG. 4–5

SYNONYMS: see Rossman et al. (1999).

DESCRIPTION & ILLUSTRATIONS: Samuels et al. (1990); Rossman et al. (1999).

ANAMORPH — *Acremonium berkeleyanum* (P. Karst.) W. Gams (Rossman et al. 1999).

SUBSTRATUM — Floral rachis of *Butia yatay* and on *Cannonia australis*.

MATERIAL EXAMINED — ARGENTINA. Entre Ríos, Dpto Colón: EL PALMAR NATIONAL PARK. Col.: Capdet, M. & Romero, A.I. 23.IV.2008 (BAFC 51675).

GEOGRAPHIC DISTRIBUTION — Argentina (Catania & Romero 2007), Brazil, Indonesia, New Zealand (Samuels et al. 1990), China (Nong & Zhuang 2005), Taiwan (Guu et al. 2007).

REMARKS — *Cosmospora vilior* is among the most common species in tropical and subtropical areas. It has been found on stromata of various members of the *Xylariaceae* in Taiwan (Guu et al. 2007). Recently, Catania & Romero (2007) reported this species on fallen twigs of *Podocarpus parlatorei* Pilg. (from the Yungas region, northwest Argentina) and on stromata of the *Diatrypaceae* family. In the current collection, the fungus grows on necks of *Cannonia australis* and on the floral rachis. The fungus has not been previously recorded in Entre Ríos province.

Melanochaeta hemipsila (Berk. & Broome) E. Müll., Harr & Sulmont,

Revue Mycol., Paris 33: 377 (1969, "1968").

PL. 1 FIG. 6–14

SYNONYMS: see Müller et al. (1969).

TELEOMORPH — ASCOMATA perithecioid, scattered, superficial, globose or pyriform, black, covered with hairs, 0.2–0.4 mm long, 0.3–0.4 mm wide. ASCI cylindrical or narrow clavate, unitunicate, eight-spored, pedicellate, with a small refractive non-amyloid apical ring. ASCOSPORES biseriate, fusiform with rounded ends, curved or straight, 5-septate, central cells greenish brown, end cells hyaline, $47\text{--}62 \times 9\text{--}13\ \mu\text{m}$.

ANAMORPH — *Sporoschisma saccardoi* E.W. Mason & S. Hughes, Mycol. Pap. 31: 20 (1949).

COLONIES velutinous, superficial, black, with mixed tufts of capitate hyphae and conidiophores. CONIDIOPHORES smooth, straight, hairy, tubular, up to 4-septate, up to $260\ \mu\text{m}$ long, $10\text{--}18\ \mu\text{m}$ wide, dark brown in the base, pale brown near the apex. CONIDIA formed enteroblastically inside the tubular collarete of the conidiogenous cells, cylindrical with ends flat, 5-septate, central cell brown, end cells much paler, $48\text{--}68 \times 12\text{--}16\ \mu\text{m}$.

SUBSTRATUM — Spathe of *Euterpe edulis*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 09.VII.2008 (BAFC 51676).

GEOGRAPHIC DISTRIBUTION — TELEOMORPH: Australia, France, Sri Lanka, Thailand (Sivichai et al. 2000). ANAMORPH: Italy, Togo, USA (Hughes 1952); Canada, Indonesia, Italy (Nag Raj & Kendrick 1975); Taiwan (Matsushima 1980); Argentina (Arambarri & Cabello 1990); Australia, Brunei Darussalam, China, Malaysia, South Africa (Goh et al. 1997); Ecuador (Sivichai et al. 2000); Cuba, Perú (Heredia Abarca et al. 2004); France, Puerto Rico (Cybertruffle's Robigalia 2009).

REMARKS — The description of *M. hemipsila* coincides with those of Sivichai et al. (2000) and Hyde et al. (2000), but the ascospores are much larger in the Argentine material ($47\text{--}62 \times 9\text{--}13$ vs $30\text{--}40 \times 7.5\text{--}10\ \mu\text{m}$). Asci were not measured in the present material because they were not fully formed. The description of *S. saccardoi* given above agrees with the descriptions of Hughes (1949), Nag Raj & Kendrick (1975), Arambarri & Cabello (1990), Sivichai et al. (2000) and Hyde et al. (2000) except for the size of the conidia ($27.5\text{--}47.5 \times 11.5\text{--}15\ \mu\text{m}$ vs $48\text{--}68 \times 12\text{--}16\ \mu\text{m}$), but measurements of conidia in the Argentine material are very close to those given by Heredia Abarca et al. (2004) ($52\text{--}68 \times 12\text{--}15\ \mu\text{m}$).

Sporoschisma nigroseptatum D. Rao & P.Rag. Rao and *S. saccardoi* are very similar species, differing mainly in conidial size. It would be interesting to revise these two species because, if they do not exhibit significant differences, it may be appropriate to synonymize them. Arambarri & Cabello (1990) recorded

S. saccardoi from Buenos Aires province, but the species has not been previously recorded from Misiones.

Considering all the differences in the anamorph and teleomorph, a new species of *Melanochaeta* could be proposed. However, this is not established here since the material was inadequate to serve as a type.

Brachysporiella gayana Bat., Bol. Secr. Agric., Pernambuco 19(1–2): 109

(1952).

PL. 2 FIG. 15–20

TELEOMORPH — *Ascotaiwania*, fide Kirk et al. (2008)

ANAMORPH — COLONIES hairy, dark brown or black. MYCELIUM immersed in the substratum, septate, smooth, brown. CONIDIOPHORES macronematous, mononematous, erect, dark brown, up to 225 µm long, 3–15 µm wide. CONIDIA obovoid to obclavate, truncate at the base, smooth, 24–41 µm long, 14–21 µm thick in the broadest part, 3–6 µm wide at the base, 3-septate, brown or olive green, basal cells progressively paler.

SUBSTRATUM — Spathe of *Euterpe edulis*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 09.VII.2008 (BAFC 51677).

GEOGRAPHIC DISTRIBUTION — Brazil, Ghana, Sierra Leone (Ellis 1959); USA (Ellis 1971); Japan (Matsushima 1975); Taiwan (Matsushima 1980); Cuba (Mercado Sierra 1981, Holubová-Jechová & Mercado Sierra 1984); Australia (Taylor & Hyde 2003); Costa Rica, Malawi, Malaysia, Puerto Rico, Venezuela (Cybertruffle's Robigalia 2009).

REMARKS — This material was identified using the key provided by Ellis (1971). The above description matches those of Holubová-Jechová & Mercado Sierra (1984) and Ellis (1971) except for small differences in conidial sizes.

Berkleasium corticola (P. Karst.) R.T. Moore, Mycologia 51(5): 735

(1961, "1959").

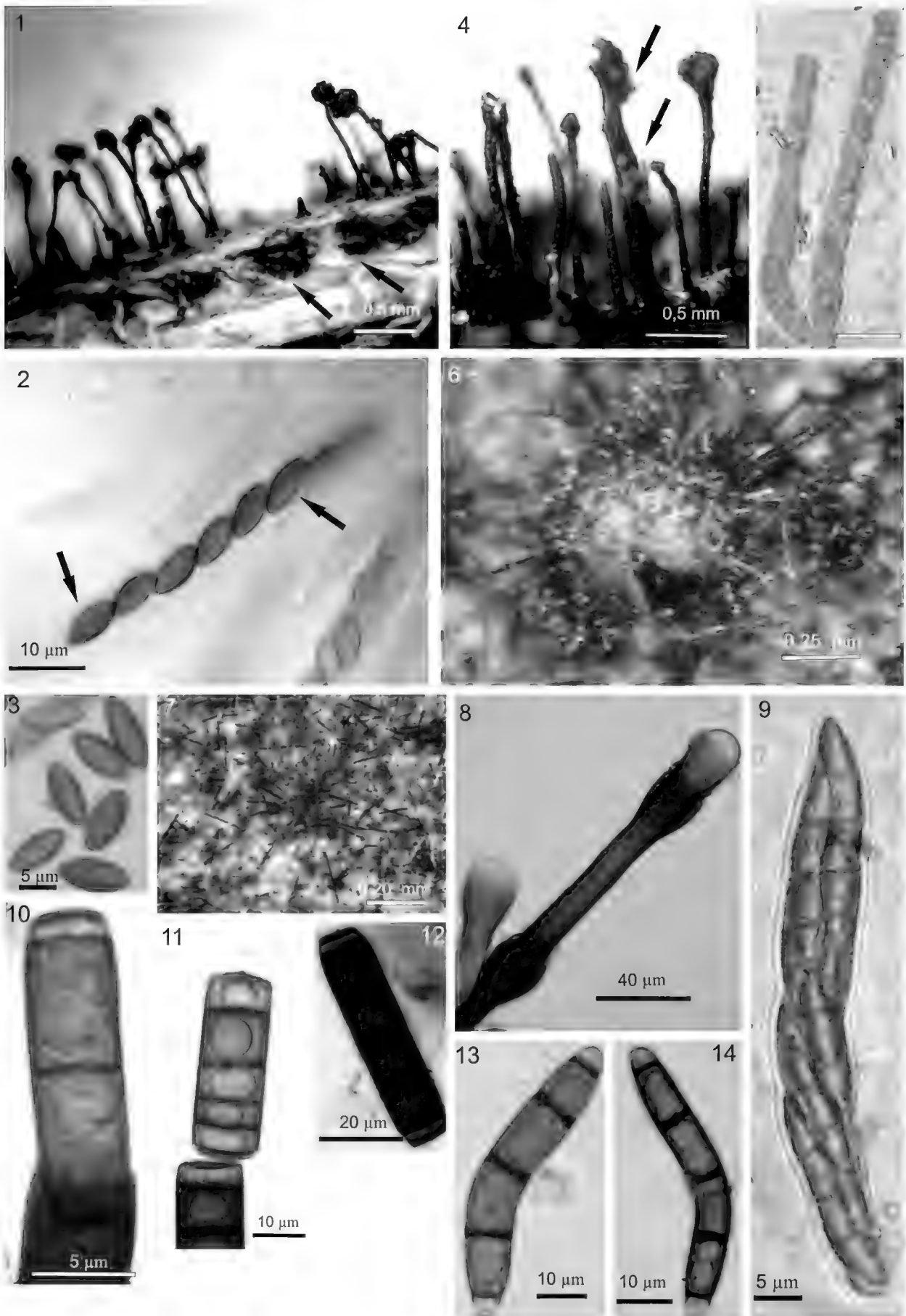
PL. 2 FIG. 21–24

TELEOMORPH — Unknown.

ANAMORPH — COLONIES composed of sporodochia, punctiform, black, shining, scattered and discrete. MYCELIUM immersed in the substratum, composed of pale brown, branched hyphae. CONIDIOPHORES simple, semimacronematous, easily broken in two or three parts. CONIDIA solitary, oval to ellipsoidal,

PLATE 1 FIGS. 1–3. *Cannonia australis*. 1: Appearance of ascomata on host surface. 2: Asci and ascospores (arrow = full length germ slit). 3: Ascospores. FIGS. 4–5. *Cosmospora vilior*. 4: *Cosmospora vilior* on ascomatal necks of *Cannonia australis*. 5: Asci. FIGS. 6–14. *Melanochaeta hemipsila*. 6: Hairy ascoma. 7: Conidiophores of *Sporoschisma saccardoi*. 8: Capitate setae. 9: Immature asci. 10: Conidiophore with conidia. 11: Chain of conidia. 12: Conidia. 13–14: Ascospores.

Scale bars: FIG. 1, 4 = 0.5 mm; FIG. 2, 11, 13–14 = 10 µm; FIG. 3, 9–10 = 5 µm; FIG. 5 = 15 µm; FIG. 6 = 0.25 mm; FIG. 7 = 0.20 mm; FIG. 8 = 40 µm; FIG. 12 = 20 µm.



irregularly muriform, brown or olive green becoming distinctly paler towards the base, smooth, slightly narrower at the septa, $18\text{--}24 \times 22\text{--}35\ \mu\text{m}$, with one hyaline conidiogenous cell sometimes present at the base, $10\text{--}13\ \mu\text{m}$ diam.

SUBSTRATUM — Spathe of *Syagrus romanzoffiana* and petiole of *Butia yatay*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 07.V.2008 (BAFC 51678); Entre Ríos, Dpto Colón: EL PALMAR NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 03.II.2009 (BAFC 51679).

GEOGRAPHIC DISTRIBUTION — Finland (Moore 1959).

REMARKS — The measurements for this species are close to those given by Moore (1959): $18\text{--}24 \times 22\text{--}35\ \mu\text{m}$ vs $18.5\text{--}26 \times 26.5\text{--}34\ \mu\text{m}$. *Berkleasium corticola* was first described by Karsten on birch from Finland, in a cold climate very different from subtropical Misiones.

Berkleasium sinense Joanne E. Taylor, K.D. Hyde & E.B.G. Jones, Fungal

Diversity Res. Ser. 12: 302 (2003).

PL. 2 FIG. 25–28

TELEOMORPH — Unknown.

ANAMORPH — SPORODOCHIA punctiform, black, shining, scattered and discrete, 0.3 mm diam. MYCELIUM immersed in the substratum, composed of pale brown, branched hyphae. CONIDIOPHORES simple, semimacronematous. CONIDIOGENOUS CELLS hyaline, terminal, cylindrical, integrated, $2.5\text{--}3\ \mu\text{m}$ diam. CONIDIA solitary, oval to ellipsoidal, irregularly muriform, brown or olive green becoming distinctly paler towards the base, smooth, slightly narrower at the septa, $42\text{--}52.5 \times 18\text{--}28.5\ \mu\text{m}$, with 1–3 hyaline subtending cells at the base $9\text{--}12\ \mu\text{m}$ diam.

SUBSTRATUM — Rachis of *Euterpe edulis*.

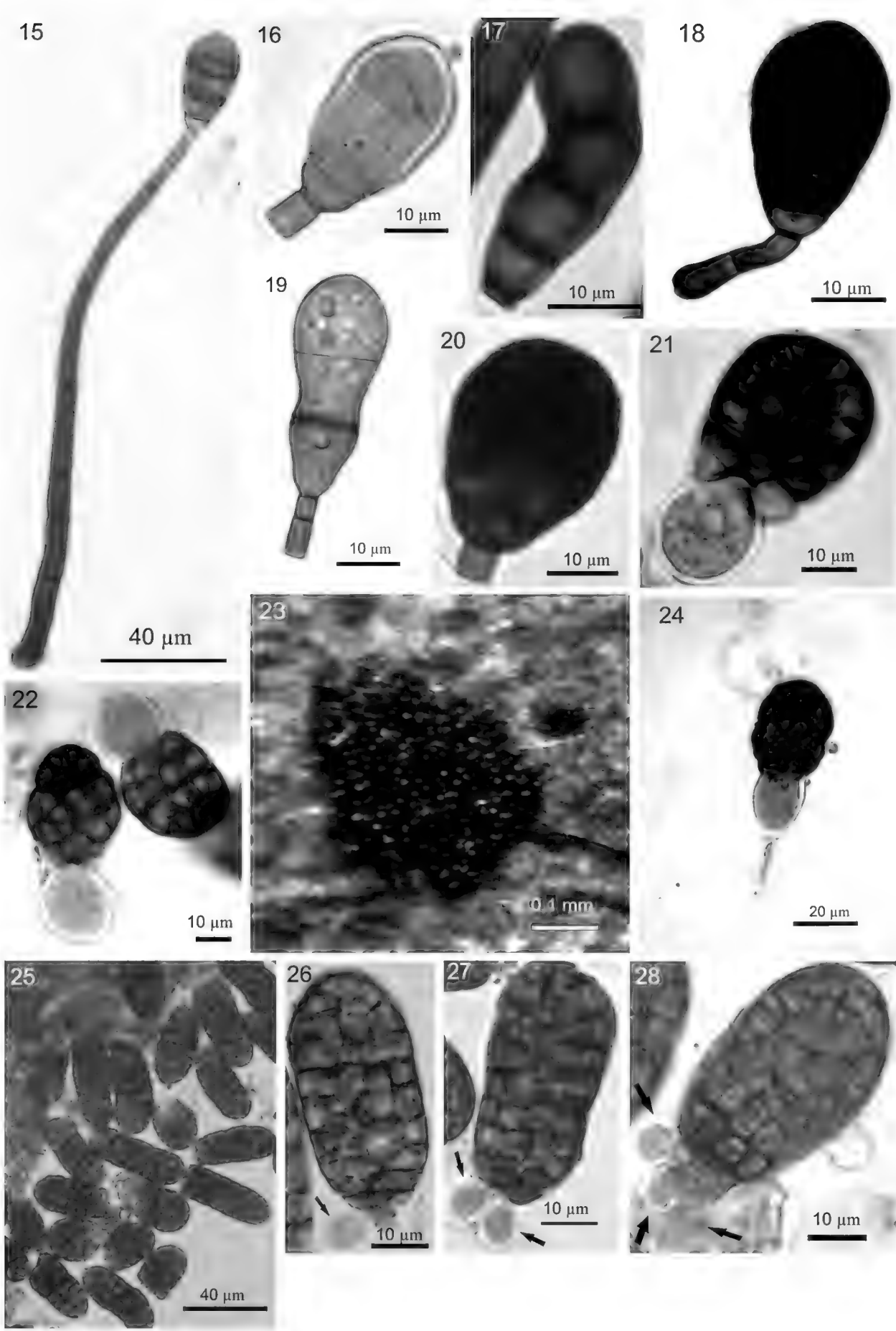
MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 16.X.2008 (BAFC 51680).

GEOGRAPHIC DISTRIBUTION — China (Taylor & Hyde 2003).

REMARKS — The genus *Berkleasium* Zobel, comprises approximately 34 species. Several have hyaline subtending cells. Measurements in the original description of *B. sinense* (Taylor & Hyde 2003) are similar to those in our material, but the subtending cells are smaller in our material. The Chinese specimen was recorded on *Trachycarpus fortunei* in a tropical climate.

PLATE 2 FIGS. 15–20. *Brachysporiella gayana*. 15: Conidiophore with conidia. 16–20: Conidia. FIGS. 21–24. *Berkleasium corticola*. 23: General aspect. 21–24: Conidia with rest of conidiogenous cells. FIGS. 25–28. *Berkleasium sinense*. Conidia (arrow = subtending cells).

Scale bars: FIG. 15, 25 = $40\ \mu\text{m}$; FIG. 16–22, 26–28 = $10\ \mu\text{m}$; FIG. 23 = $0.1\ \text{mm}$; FIG. 24 = $20\ \mu\text{m}$.



Dictyosporium cocophylum Bat., Bol. Secr. Agric., Pernambuco 18: 5
(1951).

PL. 3 FIG. 29–31

TELEOMORPH — Unknown.

ANAMORPH — COLONIES composed of sporodochia, black, opaque. CONIDIA $42\text{--}54 \times 20\text{--}24\ \mu\text{m}$, cheiroid, not complanate, consisting mostly of 7 arms of cells forming, brown or olive-brown, cylinders, arms $7\ \mu\text{m}$ wide, number of cells usually average 46 per conidia, appendages absent.

SUBSTRATUM — Floral rachis of *Butia yatay*.

MATERIAL EXAMINED — ARGENTINA. Entre Ríos, Dpto Colón: EL PALMAR NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 15.IV.2009 (BAFC 51681).

GEOGRAPHIC DISTRIBUTION — Brazil (Goh et al. 1999).

REMARKS — Compared with the description by Goh et al. (1999), conidia in the Argentine material are smaller: $42\text{--}54 \times 20\text{--}24\ \mu\text{m}$ vs $53\text{--}76 \times 19\text{--}22\ \mu\text{m}$. This may be because the conidia were not yet fully formed. This species was described from leaves of *Cocos nucifera* L. in association with lesions (Goh et al. 1999).

In Argentina, Spegazzini (1908) described *Dictyosporium yerbae* Speg. and Arambarri et al. (1987, 2001) reported two other species: *D. elegans* Corda and *D. triramosum* Aramb. et al.

Dictyosporium zeylanicum Petch, Ann. R. bot. Gdns Peradeniya 6(3):
252 (1917).

PL. 3 FIG. 32–34

TELEOMORPH — Unknown.

ANAMORPH — COLONIES sporodochia, black, opaque. MYCELIUM branched, brown. CONODIOPHORES micronematous. CONIDIOGENOUS CELLS difficult to observe. CONIDIA cheiroid, complanate, consisting mostly of 5 arms of cells, the central arm dark brown, the next 2 arms lighter brown and the outer arms even lighter, often narrower at the septa, $28\text{--}34 \times 20\text{--}23\ \mu\text{m}$, arms $5\ \mu\text{m}$ wide, number of cells usually average 28, cells which are narrower at septa appearing more or less square, appendages absent.

SUBSTRATUM — Peduncle of *Euterpe edulis*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 17.X.2008 (BAFC 51682).

GEOGRAPHIC DISTRIBUTION — Brazil (Grandi & Silva 2006); Sri Lanka (Goh et al. 1999).

REMARKS — The present specimen agrees with the description by Goh et al. (1999), the only difference being the conidial size, which is slightly smaller in the Argentine material: $26\text{--}40 \times 13\text{--}25\ \mu\text{m}$ vs $28\text{--}34 \times 20\text{--}23\ \mu\text{m}$.

Sporidesmium macrurum (Sacc.) M.B. Ellis, Mycol. Pap. 70: 53 (1958).

Pl. 3 Fig. 35–36

TELEOMORPH — Unknown.

ANAMORPH — COLONIES effuse, black, hairy. MYCELIUM partly superficial on the substratum branched, septate, hyaline to brown. CONIDIOPHORES macronematous, mononematous, up to 150 µm long, 4–5 µm wide, simple, septate, brown, swollen at the apex. CONIDIA straight or curved, rostrate, obclavate, 3- to 4-septate, smooth, becoming gradually paler towards the apex, basal cell dark brown and adjacent cell olive brown, 35–50 × 8–10 µm, 1–2 µm near the apex, 3–4 µm wide at the base.

SUBSTRATUM — Sheath of *Syagrus romanzoffiana*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 07.V.2008 (BAFC 51683).

GEOGRAPHIC DISTRIBUTION — Ghana, Indonesia, Malaysia (Ellis 1958); Papua-New Guinea (Matsushima 1971); Cuba (Holubová-Jechová & Mercado Sierra 1984); Puerto Rico (Cybertruffle's Robigalia 2009).

REMARKS — *Sporidesmium macrurum* is very common on palms. The conidia of the present collection have smooth walls and are smaller (35–50 × 8–10 µm vs 40–55 × 9–11) than those described by Ellis (1958).

Endocalyx melanoxanthus (Berk. & Broome) Petch., Ann. Bot. Lond. 22:

390. (1908) var. *melanoxanthus*

PL. 3 FIG. 37–38

TELEOMORPH — Unknown.

ANAMORPH — CONIDIOMATA scattered, cupulate or cylindrical, brightly yellow or greenish yellow, 0.35 × 0.6 mm, peridial hyphae enclosing the inner black conidial mass. CONIDIOGENOUS CELLS holoblastic, cylindrical, integrated or terminal. CONIDIA solitary, 12–17 × 10–12 µm, reniforme, round or oval, dark brown, rugose, with a hyaline germ slit.

SUBSTRATUM — Sheath, petiole, rachis and peduncle of *Syagrus romanzoffiana*. Petiole of *Euterpe edulis* and *Butia yatay*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 17.VI.2009 (BAFC 51684); 20.VIII.2008 (BAFC 51685); 24.IV.2008 (BAFC 51686); Entre Ríos, Dpto Colón: EL PALMAR NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 20.VIII.2008 (BAFC 51685).

GEOGRAPHIC DISTRIBUTION — Ghana (Hughes 1952); Sri Lanka, Jamaica, Malaysia, Papua-New Guinea, Pakistan, Philippines, Sierra Leone, USA (Ellis 1971); Taiwan (Matsushima 1980); Japan (Okada & Tubaki 1984); Cuba (Holubová-Jechová & Mercado Sierra 1984); Peru (Matsushima 1993); Mexico (Heredia et al. 2000); Puerto Rico (Cybertruffle's Robigalia 2009).

REMARKS — The examined material fits the description of Holubová-Jechová and Mercado Sierra (1984). *Endocalyx melanoxanthus* is very common in different palms, but its pathogenicity is uncertain. This anamorph was collected in all seasons and with high frequency.

Ernakulamia cochiniensis (Subram.) Subram., Kavaka 22/23: 67
(1996, “1994/1995”)

PL. 3 FIG. 39

TELEOMORPH — Unknown.

ANAMORPH — COLONIES effuse, dark brown or black. MYCELIUM superficial. CONIDIA solitary, muriform, variable in shape, obconical or piriform, dark brown or black, often verrucose, $43\text{--}97 \times 31\text{--}65 \mu\text{m}$, with up to 12-septate appendages, pale brown, up to $90 \mu\text{m}$ long, $3\text{--}4 \mu\text{m}$ wide.

SUBSTRATUM — Spathe of *Syagrus romanzoffiana*.

MATERIAL EXAMINED — ARGENTINA. Misiones, Dpto Iguazú: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 07.V.2008 (BAFC 51687).

GEOGRAPHIC DISTRIBUTION — India (Ellis 1976); Japan, Mexico (Heredia Abarca et al. 1997); Cuba (Holubová-Jechová & Mercado Sierra 1986; Mercado Sierra et al. 1997, 2005); Malaysia (Cybertruffle's Robigalia 2009).

REMARKS — Subramanian (1996) proposed the genus *Ernakulamia* for *Petrakia cochiniensis* Subram., because he considered it as distinct from the type species *Petrakia echinata* (Peglion) Syd. & P. Syd. and *Piricauda* Bubák to which Ellis (1976) had transferred the taxon as *Piricauda cochiniensis* (Subram.) M.B. Ellis. Most authors (Heredia Abarca et al. 1997, Taylor & Hyde 2003, Mercado Sierra et al. 1997, 2005) follow Ellis (1976) and retain the species in *Piricauda* without taking into account Subramanian (1996).

The above description of this species agrees with descriptions by Ellis (1976), Heredia Abarca et al. (1997), and Mercado Sierra et al. (1997, 2005); the conidial size range in the Argentine collection includes the size range given by Heredia Abarca et al. (1997): $43\text{--}97 \times 31\text{--}65 \mu\text{m}$ vs $60\text{--}73 \times 55\text{--}65 \mu\text{m}$.

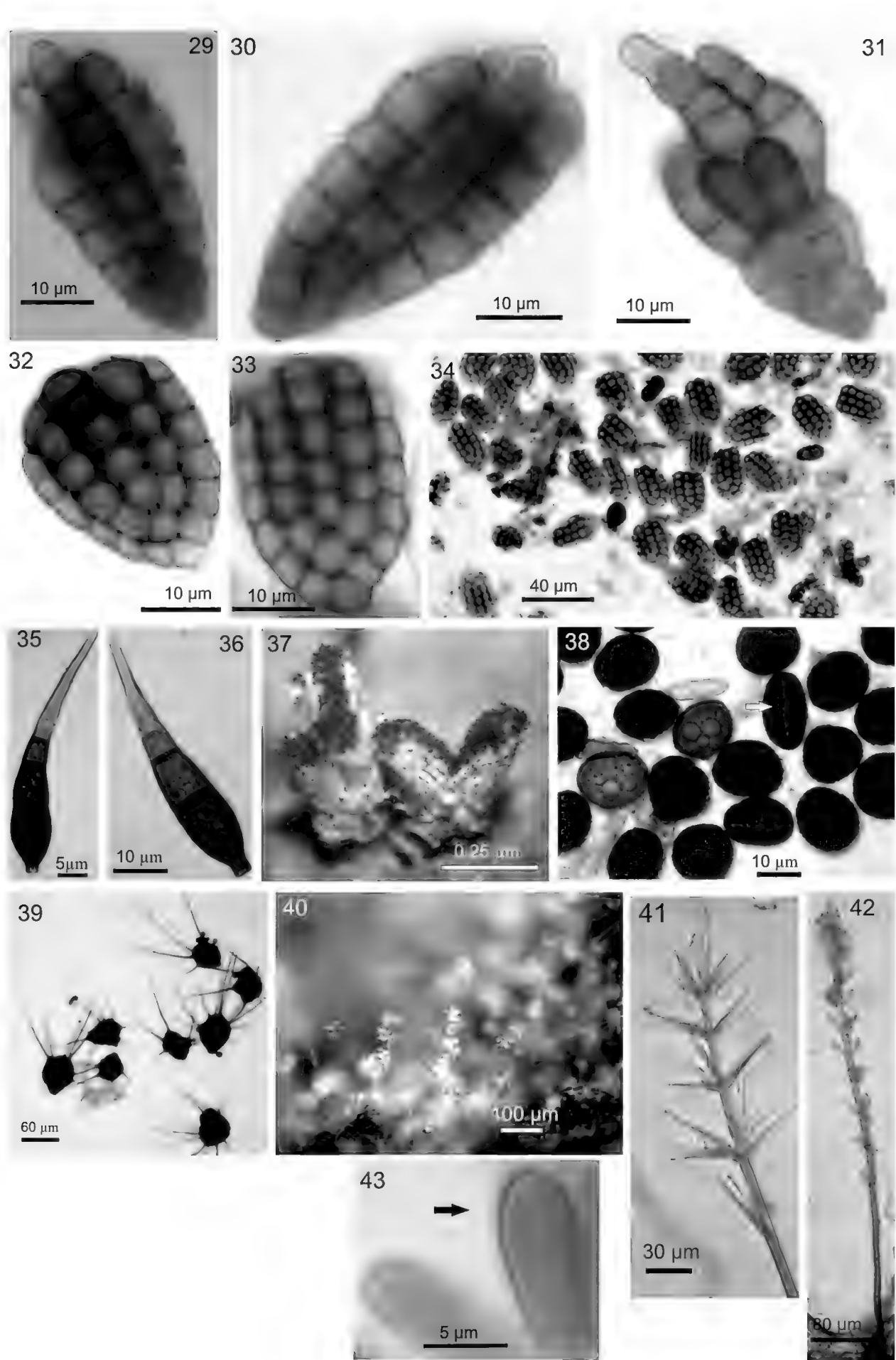
Musicillium theobromae (Turconi) Zare & W. Gams, Nova Hedwigia 85(3–4):
482 (2007).

PL. 3 FIG. 40–41

TELEOMORPH — Unknown.

PLATE 3 FIGS. 29–31. *Dictyosporium cocophyllum*. Conidia. FIGS. 32–34. *Dictyosporium zeylanicum*. Conidia. FIGS. 35–36. *Sporidesmium macrurum*. Conidia. FIGS. 37–38. *Endocalyx melanoxanthus* var. *melanoxanthus*. 37: General aspect of ascomata. 38: Conidia (arrow= full length germ slit). FIG. 39. *Ernakulamia cochiniensis*. Conidia. FIGS. 40–41. *Musicillium theobromae*. 40: Aspect general. 41: Conidiogenous cells. FIGS. 42–43. *Stachylidium bicolor*. 42: Conidiophore. 43: Conidiophore with echinulate conidiogenous cells.

Scale bars: FIG. 29–33, 36, 38 = $10 \mu\text{m}$; FIG. 34 = $40 \mu\text{m}$; FIG. 36, 43 = $5 \mu\text{m}$; FIG. 37 = 0.25 mm ; FIG. 39 = $60 \mu\text{m}$; FIG. 40 = $100 \mu\text{m}$; FIG. 41 = $30 \mu\text{m}$; FIG. 42 = $80 \mu\text{m}$.



ANAMORPH — COLONIES scattered, pilose, black or brown. MYCELIUM composed of immersed, smooth, branched hyphae, septate, hyaline or brown, 2.5–3.5 μm wide. CONIDIOPHORES straight, enclosed, dark brown at the base to light brown at the apex, up to 360 μm long, 4.5–7.5 μm wide. CONIDIOGENOUS CELLS in whorls of 3–6, hyaline, scarcely tapering towards the tip, 15–65 μm long, 2–5 μm wide at the base. CONIDIA cylindrical or spherical, hyaline 3–7 \times 2–3 μm .

SUBSTRATUM — Floral rachis of *Euterpe edulis*.

MATERIAL EXAMINED — ARGENTINA. MISIONES, DPTO IGUAZÚ: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 16.X.2008 (BAFC 51688).

GEOGRAPHIC DISTRIBUTION — Spain, Colombia, Portugal, Jamaica, Zimbabwe (Hughes 1951); Taiwan (Matsushima 1980); Georgia (Holubová-Jechová 1980), Cuba (Mercado Sierra et al. 1997); Brazil, Egypt, India, Iran, Nigeria (Zare et al. 2007); Australia, Nicaragua, Oman, Puerto Rico, Trinidad & Tobago, Venezuela (Cybertruffle's Robigalia 2009).

REMARKS — *Musicillium theobromae* is perhaps best known as *Verticillium theobromae* (Hawksworth & Holliday 1970a), but Zare et al. (2007) recently established a new genus, *Musicillium*, based mainly on molecular characters. This species is a causal agent of “cigar-end rot” of banana. Morphologically similar to *V. albo-atrum* Reinke & Berthold, which also produces have dark conidiophores, *Musicillium theobromae* differs in its smaller conidia (3–7 \times 2–3 μm vs 3.5–10.5 (–12.5) \times 2–4 μm) and torulose mycelium (Hawksworth & Holliday 1970b).

Stachylidium bicolor Link, Mag. Gesell. Naturf. Freunde, Berlin 3: 15 (1809).

Pl. 3 Fig. 42–43

TELEOMORPH — Unknown.

ANAMORPH — COLONIES scattered, olivaceous brown. MYCELIUM immersed in the substratum. CONIDIOPHORES solitary or clustered, up to 600 μm long, 3–5 μm wide, unbranched, septate, brown and light brown towards the apex, echinulate from the middle towards the apex, with whorls of 2–6 conidiogenous cells from the mid point upwards. CONIDIOGENOUS CELLS oval to oval-cylindrical, pale brown, echinulate, 9–14 \times 4–5 μm . CONIDIA cylindrical to ellipsoidal, smooth, pale brown, oval, 4–6 \times 2–2.5 μm .

SUBSTRATUM — Floral rachis of *Euterpe edulis*.

MATERIAL EXAMINED — ARGENTINA. MISIONES, DPTO IGUAZÚ: IGUAZÚ NATIONAL PARK. Col. Capdet, M. & Romero, A.I. 16.X.2008 (BAFC 51724).

GEOGRAPHIC DISTRIBUTION — Ghana (Hughes 1952); Japan (Matsushima 1975); Uganda (Matsushima 1980); Georgia (Holubová-Jechová 1980); Mexico (Heredia Abarca et al. 1997); Cuba, Malaysia, New Zealand, Papua-New Guinea, Sierra Leone, Solomon Islands, Taiwan, Venezuela, Zimbabwe (Cybertruffle's Robigalia 2009).

REMARKS — The description matches that by Matsushima (1975, 1980) except for conidial sizes which are, however, within the range he provided.

Acknowledgments

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Literature cited

- APN (Administración de Parques Nacionales). 2008. Parque Nacional El Palmar. http://www.parquesnacionales.gov.ar/03_ap/11_palmar_PN/11_palmar_PN.htm
- Arambarri AM, Cabello MN, Mengascini A. 1987. Estudio sistemático de los Hyphomycetes del Río Santiago. (Prov. de Buenos Aires, Argentina). *Darwiniana*. 28(1–4): 293–301.
- Arambarri AM, Cabello MN. 1990. Estudio sistemático de los Hyphomycetes del Río Santiago. IV. (Buenos Aires, Argentina). *Boletín de la Sociedad Argentina de Botánica*. 26(3–4): 143–148.
- Arambarri AM, Cabello MN, Cazau MC. 2001. *Dictyosporium triramosum*, a new hyphomycete from Argentina. *Mycotaxon* 78: 185–189.
- Blombery A, Rodd T. 1982. An informative, practical guide to palms of the world: their cultivation, and landscape use. Angus & Robertson Book (Australia). 199 pp.
- Cabral EL, Castro M. 2007. Palmeras Argentinas, guía para el reconocimiento. Literature of Latin America: Buenos Aires (República Argentina). 88 pp.
- Cabrera AL, Willink A. 1980. Biogeografía de América Latina. 2 ° ed. O.E.A., Washington, D.C. 130 pp.
- Carmona MA, Zapata HL, Whright ER. 1990. Mancha foliar del pindó (*Arecastrum romanzoffianum*) ocasionada por *Pestalotiopsis palmarum*. *Rev. Facultad de Agronomía* 11(2–3): 101–105.
- Catania M del V, Romero AI. 2007. Contribution to the study of Ascomycetes on *Podocarpus parlatorei* Pilg. In Tucumán and Catamarca provinces (Argentina). *Asociación de Biología de Tucumán*. *Biocell* 31(2): 263.
- Chebez JC. 1994. Los que se van. Especies Argentinas en peligro. Editorial Albatros: Buenos Aires (República Argentina). 604 pp.
- Cúndom MA, Cabrera MG, Cejas P. 2006. Manejo Integrado de Plagas y Agroecología (Costa Rica) 77: 82–85.
- Cybertruffle's Robigalia. 2009. Observations of fungi and their associated organisms. [www.cybertruffle.org.uk/robigalia/eng, website accessed].
- Dirección de Bosques. Secretaría de Ambiente y Desarrollo Sustentable. 2003. Atlas de los Bosques Nativos Argentinos. Secretaría de Ambiente y Desarrollo Sustentable: Buenos Aires (Argentina). 243 pp.
- Ellis MB. 1958. *Clasterosporium* and some allied *Dematiaceae-Phragmosporae* I. *Mycological Papers* 70: 1–89.
- Ellis MB. 1959. *Clasterosporium* and some allied *Dematiaceae-Phragmosporae* II. *Mycological Papers* 72: 1–75.
- Ellis MB. 1971. Dematiaceous hyphomycetes. Commonwealth Agricultural Bureaux: Farnham Royal, Slough (England). 608 pp.

- Ellis MB. 1976. More dematiaceous hyphomycetes. Commonwealth Agricultural Bureaux: Farnham Royal, Slough (England). 507 pp.
- Fröhlich J, Hyde KD. 2000. Palm microfungi. Fungal Diversity Press. Hong Kong (China). 247 pp.
- Galindo-Leal C, Gusmão Câmara I. (eds.). 2003. The Atlantic Forest of South America: biodiversity status, threats and outlook. Publisher: Washington (EEUU) Island Press. 488 pp.
- Goh TK, Ho WH, Hyde KD, Umali TE. 1997. New record and species of *Sporoschisma* and *Sporoschismopsis* from submerged wood in the tropics. Mycological Research 101: 1295–1307.
- Goh TK, Hyde KD, Ho WH, Yanna. 1999. A revision of the *Dictyosporium*, with descriptions of three new species. Fungal Diversity 2: 65–100.
- Grandi RAP, Silva TV. 2006. Fungos anamorfos decompositores do folheto de *Caesalpinia echinata* Lam. Revista Brasileira de Botânica. 29(2): 257–287.
- Guu JR, Ju YM, Hsieh HJ. 2007. Nectriaceous fungi collected from forests in Taiwan. Botanical Studies 48: 187–203.
- Hawksworth DL, Holliday P. 1970a. *Verticillium theobromae*. CMI Descriptions of pathogenic fungi and bacteria N°259. CMI, Kew, Surrey, England.
- Hawksworth DL, Holliday P. 1970b. *Verticillium albo-atrum*. CMI Descriptions of pathogenic fungi and bacteria. N°255. CMI, Kew, Surrey, England.
- Heredia Abarca G, Mena Portales J, Mercado Sierra A, Reyes Estebanez M. 1997. Tropical Hyphomycetes of Mexico. II. Some species from the tropical biological station “Los Tuxtlas”, Veracruz, Mexico. Mycotaxon 64: 203–233.
- Heredia G, Arias RM, Reyes M. 2000. Contribución al conocimiento de los hongos hyphomycetes de México. Acta Botánica Mexicana 51: 39–51.
- Heredia Abarca G, Reyes Estebanez M, Arias Mota RM. 2004. Adiciones al conocimiento de la diversidad de los hongos conidiales del bosque mesófilo de la montaña del Estado de Veracruz. Acta Botánica Mexicana 66: 1–22.
- Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part I: The Herbaria of the world. New York Botanical Garden: New York (U.S.A.). 693 pp.
- Holubová-Jechová V. 1980. Lignicolous and some other saprophytic hyphomycetes from the USSR. I. Eesti NSV Tead.Akad. Toim., Biol., 29: 131–147.
- Holubová-Jechová V, Mercado Sierra A. 1984. Studies on Hyphomycetes from Cuba II. Hyphomycetes from the Isla de la Juventud. Česká Mykologie 38(2): 96–120.
- Holubová-Jechová V, Mercado Sierra A. 1986. Dematiaceous hyphomycetes from the Province Pinar del Rio. Česká Mykologie 40: 142–164.
- Hyde KD, Cannon, PF. 1999. Fungi causing tar spots on palms. Mycological Papers, N° 175: 1–114.
- Hyde KD, Fröhlich J. 1997. Fungi from palms. XXXVII. The genus *Astrophariella*, including ten new species. Sydowia 50(1): 81–132.
- Hyde KD, Fröhlich J, Taylor JE. 1998. Fungi from palms. XXXVI. Reflections on unitunicate ascomycetes with apiospores. Sydowia 50(1): 21–80.
- Hyde KD, Taylor JE, Fröhlich J. 2000. Genera of *Ascomycetes* from palms. Fungal Diversity Press. Hong Kong (China). 247 pp.
- Hughes SJ. 1949. Studies on micro-fungi. II. The genus *Sporochisma* Berkeley & Broome and a re-description of *Helminthosporium rousseleanum* Montagne. Mycological Papers 31: 1–33.
- Hughes SJ. 1951. Studies on Micro-fungi. XI. Some hyphomycetes which produce phialides. Mycological Papers 45: 1–36.
- Hughes SJ. 1952. Fungi from the Gold Coast. I.. Mycological Papers 48: 1–91.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi 10th Edition, CAB International, Oxon, UK. 771 pp.

- Nag Raj TR, Kendrick B. 1975. A monograph of *Chalara* and allied genera. Wilfrid Laurier University Press. Ontario (Canada). 200 pp.
- Nong Y, Zhuang W-Y. 2005. Preliminary Survey of *Bionectriaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*) from Jigongshan, China. *Fungal Diversity* 19: 95–107.
- Matsushima T. 1971. Microfungi of the Salomon Islands and Papua-New Guinea. Published by the author, Kobe (Japan). 78 pp.
- Matsushima T. 1975. Icones microfungia Matsushima Lectorum. Published by the author, Kobe (Japan). 209 pp.
- Matsushima T. 1980. Saprophytic microfungi from Taiwan. Hyphomycetes. Matsushima Mycological Memoirs 1. Published by the author. Kobe (Japan). 82 pp.
- Matsushima T. 1993. Matsushima Mycological Memoirs 8. Published by the author. Kobe (Japan). 75 pp.
- Mercado Sierra A, Holubová-Jechová V, Mena Portales J. 1997. Hifomicetes dematiáceos de Cuba enteroblásticos. Monographie XXIII. Museo Regionale Di Scienza Naturali, Torino. 388 pp.
- Mercado Sierra A. 1981. Lista preliminar de hifomicetes dematiáceos de la Estación Ecológica de Sierra del Rosario y zonas adyacentes. *Acta Bot. Cubana*, La Habana, 6: 1–6.
- Mercado Sierra A, Guarro J, Heredia G. 2005. The hyphomycete genus *Piricauda*, with description of a new species. *Mycological Research* 109(6): 723–728.
- Moore RT. 1959. The genus *Berkleasmiium*. *Mycologia* 51(5): 734–739.
- Müller E, Harr J, Sulmont P. 1969. Deux Ascomycetes dont le stand conidien presente des conidias phaeophragmiées (endogènes). *Revue de Mycologic* 33: 369–378.
- Okada G, Tubaki K. 1984. A new species and a new variety of *Endocalyx* (*Deuteromycotina*) from Japan. *Mycologia*, 76(2): 300–313.
- Rossmann AY, Samuels GJ, Rogerson CT, Lowen R. 1999. Genera of *Bionectriaceae*, *Hypocreaceae* and *Nectriaceae* (*Hypocreales*, *Ascomycetes*). *Studies in Mycology* 42: 1–248.
- Samuels GJ, Doi Y, Rogerson CT. 1990. *Hypocreales*. *Memoirs of the New York Botanical Garden* 59: 6–108.
- Sivichai S, Hywel-Jones NL, Somrithipol S. 2000. Lignicolous freshwater *Ascomycota* from Thailand: *Melanochaeta* and *Soporoschisma* anamorph. *Mycological Research* 104(4): 478–485.
- Spegazzini C. 1881. Fungi Argentini: Additis Nonnullis Brasiliensibus Montevideensibusque. *Pugillus IV*. *Anales de la Sociedad Científica Argentina*. 12(3): 97–117.
- Spegazzini C. 1908. Hongos de la Yerba Mate. *Anales del Museo Nacional de Buenos Aires* 17: 138–139.
- Subramanian CV. 1996 (“1994/1995”). Hyphomycetes from South East Asia–Novelties from Singapore and Malaysia. *Kavaka* 22/23: 52–76.
- Taylor JE, Hyde KD. 1999. *Cannonia* gen.nov., from palms in the southern hemisphere. *Mycological Research* 103(11): 1398–1402.
- Taylor JE, Hyde KD. 2003. Microfungi of tropical and temperate palms. *Fungal Diversity Press*. Hong Kong (China). 459 pp.
- Zare R, Gams W, Starink-Willemse M, Summerbell RC. 2007. *Gibellulopsis*, a suitable genus for *Verticillium nigrescens*, and *Musicillium*, a new genus for *V. theobromae*. *Nova Hedwigia* 85 (3–4): 463–489.

Lichens of Ordu Province, Turkey

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Abstract – 314 taxa belonging to 99 genera are reported from Ordu province in the Central Black Sea region of Turkey. 263 taxa are reported for the first time from the province, and three species, *Arthopyrenia persoonii*, *Sphinctrina leucopodia*, and *Verrucaria submersella*, are new records for Turkey. The full checklist is available on <http://www.mycotaxon.com/resources/weblists.html>

Key words – Aydoğan hill, biota, biodiversity

Introduction

In the last two decades lichenological studies in Turkey have increased remarkably (e.g., Candan & Özdemir Türk 2008, Halıcı & Aksoy 2009, John & Nimis 1998, Kinalioğlu 2009, Özdemir Türk 2003, Öztürk et al. 2005, Yazıcı & Aptroot 2008). However, the lichen composition of some provinces is still insufficiently known. One of these provinces is Ordu, situated in the central part of the Black Sea region of Turkey (FIG. 1). There have been four studies referring to lichens in Ordu province (Steiner 1909, Kinalioğlu et al. 1998, John et al. 2000, Aslan et al. 2006). In these studies, a total of only 94 lichen taxa are cited from the province, suggesting that its lichen biota is very poorly known. The present study adds further information to our knowledge of the lichen biota of Turkey and in particular of Ordu.

Data here are compiled from Ordu, based on collections from 63 sites visited between 20 March 2004 and 2 November 2008. Turkey has three main floristic regions: the Euro-Siberian floristic region, the Mediterranean floristic region, and the Irano-Turanian floristic region. Ordu is located within the boundaries of the Euxianian section of the Euro-Siberian floristic region. It is situated at 40°18'–41°08' N, 36°52'–38°12' E at altitudes ranging from sea level to 3038 m. The province has an area of 6001 km², generally of rough topography. The most important peaks of Ordu are Kırğızlar peak (3038 m), Aşit peak (2569 m), Eriço peak (2298 m), Deveci Mountain (1907 m), and Aydoğan peak

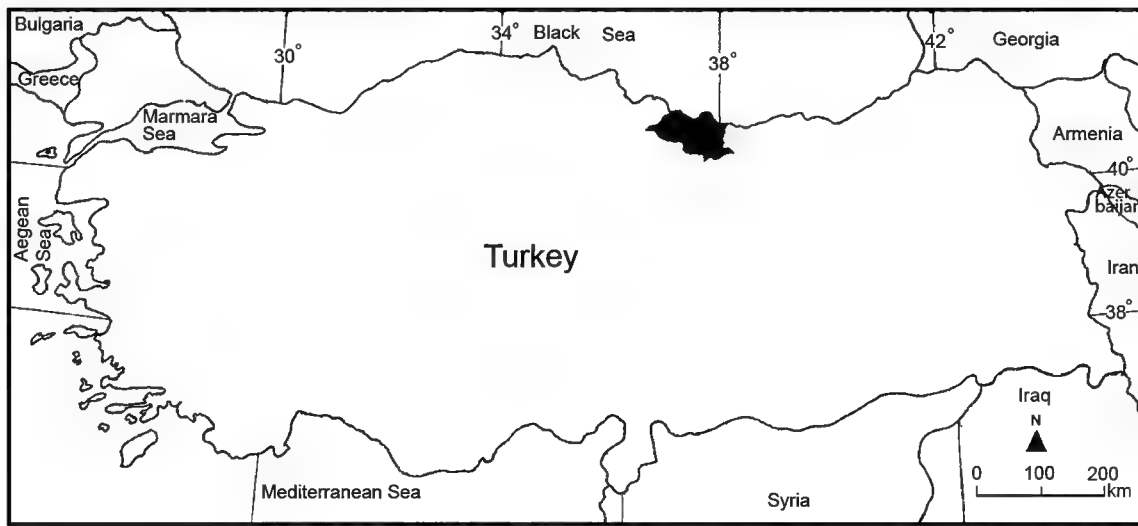


FIG. 1. Map of Turkey showing Ordu province.

(1971 m). There are also some facies plateaux at high altitudes, mainly Çambaşı, Perşembe, Keyfalan, Topçam, Argan, and Aydoğan. Upper Cretaceous volcanic facies (agglomerata, dacite, diorite, granodiorit) are mostly present. There are various big streams in the province such as Melet stream, Bülbül stream, and Civil stream. Small plains, which cover relatively minor areas, exist near the coastal area and stream mouths. The wide altitudinal variation, rough topography, influence of the adjacent sea, and big streams of the Ordu provide a wide range of climatic zones. However, oceanic climate prevails in Ordu. The mean rainfall per year is 1029.2 mm, the highest precipitations occur in October and December and the lowest in May and July. On average, there are 178 rainy days and 6 snowy days on a yearly basis. The mean annual maximum temperature is 27.5°C in August, while the mean minimum temperature is 3.9°C in February. The mean annual relative humidity is 76%. Vegetation cover varies with climate and altitude. Up to 1500 m, deciduous trees (*Alnus* spp., *Carpinus* spp., *Castanea sativa*, *Fagus orientalis*, *Quercus* spp.) and shrubs (e.g., *Corylus* spp., *Rhododendron* spp.) prevail. *Corylus* species are important crop plants as well. At 1500–1900 m the forest consists of *Picea orientalis* and *Pinus sylvestris* (Atalay 1994), which provide suitable habitats for a rich lichen flora. Above 1900 m alpine meadows are dominant.

Materials and methods

The collections were identified following standard techniques using various lichen guides (Brodo et al. 2001, Goward 1999, Purvis et al. 1992, Wasser 2005, Wirth 1995). Air-dried samples were examined using a stereo microscope and a light microscope. All samples are stored in the herbarium of the Faculty of Science and Arts, Giresun University, Giresun, Turkey. Lichen species new to Turkey are indicated by # in the Checklist, those new to Ordu province by *.

Results and discussion

Three of the lichen species in the Checklist are newly recorded for Turkey: *Arthopyrenia persoonii* A. Massal., *Sphinctrina leucopoda* Nyl., and *Verrucaria submersella* Servit are newly recorded for Turkey. *Arthopyrenia persoonii* might have been overlooked in Turkey in the past because of its inconspicuous appearance; the species, which colonizes the bark of deciduous trees such as *Fraxinus* sp. and *Juglans* sp. in Europe (Wirth 1994 & Berger et al.), was collected from the smooth bark of *Juglans regia*.

Sphinctrina leucopoda is pathogenic or commensalistic on *Pertusaria pertusa* (more rarely on other *Pertusaria* and *Diploschistes* species), in Europe and America particularly on old deciduous trees (Purvis et al. 1992); in Ordu it was lichenicolous on *Pertusaria pertusa* on *Corylus* sp. at 1080 m. *Verrucaria submersella*, which grows on wet noncalcareous rocks in the mountains of middle Europe (Ozenda & Clauzade 1970, Clauzade & Roux 1985), seems restricted to the stream banks at altitudes >1800 m. *Ionaspis lacustris* and *Usnea intermedia* are recorded for the second time from Turkey. *Ionaspis lacustris* is known throughout Europe and North America (Purvis et al. 1992) and in Europe is mainly found in the mediterranean mountain regions. In Turkey, it has been previously recorded from Akşehir (Steiner 1916). *Usnea intermedia* is known from Europe often on coniferous trees in submontane environments (Randlane et al. 2009); in Turkey, it was previously recorded from Bursa (Verseghe 1982).

The richness of geographical features of the Ordu (wide altitudinal range, rough topography and maritime influence) offers a wide range of niches so that a rich lichen biodiversity can be expected. Furthermore, due to the ecological features of the province, lichen species distributed elsewhere in Europe, America, and Asia co-occur with local lichens, leading to a rich lichen diversity. The number of known lichen taxa in Ordu, including records from the present study, is now 357. However, additional studies are necessary to extend the knowledge of the Ordu lichen biota, with the inner parts of the province particularly poorly explored.

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Literature cited

- Aslan A, Budak G, Tıraşoğlu E, Karabulut A. 2006. Determination of elements in some lichens growing in Giresun and Ordu province (Turkey) using energy dispersive X-ray fluorescence spectrometry. *Journal of Quantitative Spectroscopy and Radiative Transfer* 97: 10–19.

- Atalay İ. 1994. Türkiye Vegetasyon Coğrafyası. Ege Üniversitesi Basımevi, Bornova, İzmir.
- Berger F, Priemetzhofer F, Türk R. 1998. Neue und seltene Flechten und lichenicole Pilze aus Oberösterreich, Österreich IV. Beitr. Naturk. Oberösterreichs 6: 397–416.
- Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press, London.
- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). Mycotaxon 105: 19–22.
- Clauzade G, Roux C. 1985. Likenoj de Okcidenta Europo. Ilustrita Determinlibro. Bulletin de la Societe Botanique du Centre-Ouest, Nouvelle Serie, Numero Special 7. Royan, France.
- Goward T. 1999. The lichens of British Columbia, Illustrated keys, Part 2, Fruticose Species. British Columbia Ministry of Forests.
- Halıcı MG, Aksoy A. 2009. Lichenised and Lichenicolous Fungi of Aladağlar National Park (Niğde, Kayseri and Adana Provinces) in Turkey. Turk. J. Bot. 33: 169–189.
- John V, Nimis PL. 1998. Lichen flora of Amanos mountain and the province of Hatay. Turk. J. Bot. 22: 257–267.
- John V, Seaward MRD, Beaty JW. 2000. A neglected Lichen Collection from Turkey: Berkhamsted School Expedition 1971. Turk. J. Bot. 24: 239–248.
- Kınalıoğlu K, Engin A, Gönülol A. 1998. Hoşgadem (Ordu-Aybastı) Yaylası Liken Florası Üzerine Bir Araştırma. 14. Ulusal Biyoloji Kongresi, Samsun, 476–483.
- Kınalıoğlu K. 2009. Lichens from the Amasya, Çorum, and Tokat regions of Turkey. Mycotaxon 109: 181–184.
- Özdemir Türk A. 2003. Two New Records For the Lichen Flora of Turkey. Turk. J. Bot. 27: 69–70.
- Öztürk Ş, Güvenç Ş, Aydın S. 2005. Floristic Lichen Records from Isparta and Burdur Provinces. Turk. J. Bot. 29: 243–250.
- Ozenda, P, Clauzade G. 1970: Les Lichens. Etude Biologique et Flore Illustree. Masson & Cie, Editeurs, Paris.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The Lichen Flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.
- Randlane T, Törre T, Saag A, Saag L. 2009. Key to European Usnea species. Bibliotheca Lichenologica, 100: 419 - 462.
- Steiner, J. 1909. Lichenes. In: Handel Mazzetti DHFV. Ergebnisse einer botanischen Reise in das Pontische Randgebirge im Sandschak Trapezunt, etc. Annal. Naturhist. Hofmus. Wien 23: 107–123.
- Steiner J. 1916. Aufzählung der von J. Börmüller im Oriente gesammelten Flechten. Anal. Naturhist. Mus. Wien 30: 24–39.
- Verseghe KP. 1982. Beiträge zur Kenntnis der Türkischen Flechtenflora. Studia Botanica Hungarica 16: 53–65.
- Wasser SP, Nevo E. 2005. Lichen-forming, Lichenicolous, and Allied Fungi of Israel. International Center for Cryptogamic Plants and Fungi, Institute of Evolution, University of Haifa, Israel.
- Wirth V. 1995. Die Flechten Baden-Württembergs. Ulmer, Stuttgart.
- Yazıcı K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. Mycotaxon 105: 95–104.

Lichenological notes 1: *Acarosporaceae*

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Abstract — A neotype is designated for *Acarospora interjecta*. *Acarospora pyrenopsoides* is not recognized as occurring in Canada. *Sarcogyne crustacea* is a new name for *Biatorella terrena*, a rare terricolous species from southern California, which is revised.

Key words — biological soil crusts, lichenicolous lichens

1. *Acarospora interjecta* H. Magn., Meddel. Göteborgs Bot. Trädgård 5: 69 (1930).

TYPE: U.S.A. NEW MEXICO: LAS VEGAS, 1927, Bro. G. Arsène 19749 (FH, NEOTYPE designated here).

Acarospora interjecta is a lichenicolous lichen parasitic on the yellow effigurate *Acarospora novomexicana* H. Magn. It was described from a single specimen in the herbarium of Bouly de Lesdain collected by Brother G. Arsène in New Mexico (Magnusson 1930). The holotype is believed to have been lost in the bombing of Dunkirk during WW2 when B. de Lesdain's herbarium was destroyed. No isotypes were cited in the original publication. At Farlow Herbarium (FH), the first author examined specimens of *A. novomexicana* collected in Las Vegas, New Mexico, by Brother G. Arsène, searching for other possible specimens of *A. interjecta*. Only one specimen of *A. interjecta* was found, but with several apothecia, growing on a paratype of *Acarospora novomexicana* on sandstone. It perfectly matches the protologue (Magnusson 1930) which, based on a scanty type, describes a brown species with rather thick paraphyses (2–3 µm), broadly globose to ellipsoid ascospores (3–4 × 2–2.5 µm) and asci (70–80 × 20 µm) with about 100 ascospores per ascus. The hymenium ranged from 100–170 µm in height. We further observed that the ascospores begin globose but in

maturity become broadly ellipsoid [a development seen in some species like *A. strigata* (Nyl.) Jatta] and have a distinct perispore. We designate this specimen as a neotype.

Three other parasitic species of *Acarosporaceae* known from North America have ascospores with distinct perispores: two lichenicolous lichens [*Acarospora stapfiana* (Müll. Arg.) Hue on *Caloplaca* species and *A. succedens* H. Magn. on *Dimelaena oreina* (Ach.) Norman (Knudsen 2008a)] and one lichenicolous fungus [*Sarcogyne sphaerospora* J. Steiner on *Candelariella* species (Lendemer et al. 2009)]. Magnusson compared *A. interjecta* to *A. anatolica* H. Magn., a parasitic species known only from the holotype collected in Turkey on *D. oreina* (Magnusson 1930). *Acarospora anatolica* differs mainly from *A. interjecta* in having thinner paraphyses (1–1.5 µm) and in developing a thick elongated mycelial base (gomphate). The type of *A. anatolica* (BP) is scant and we hope to eventually evaluate new collections from Turkey.

2. *Acarospora pyrenopsoides* H. Magn., Meddel. Göteborgs Bot. Trädgård 2: 74 (1926).

TYPE: GREENLAND. NENNESE, J. Vahl (UPS, HOLOTYPE).

Acarospora pyrenopsoides was described from a collection by J. Vahl from Nennese on the east coast of Greenland (Magnusson 1926). It is a brown *Acarospora*, lacking secondary metabolites, forming a contiguous thallus several centimeters wide. For a description see Magnusson (1929: 156–157, not on page 356 as listed in the monograph index!). Magnusson considered it a distant relative of *A. nitrophila* H. Magn. and reported other specimens from Austria, Denmark, and Finland (Magnusson 1929). *Acarospora pyrenopsoides* was reported from Ellesmere Island in the Nunavut Territory of Canada (Thomson & Scotter 1985). The species is included on the checklist of the lichen-forming, lichenicolous, and allied fungi of the continental United States and Canada based on that report (Esslinger 2009). The collection was made by George W. Scotter and determined by John W. Thomson, who put a question mark by his determination. The first author recently compared the Scotter collection with the holotype from Greenland and they are not conspecific, differing distinctly in thallus types. Scotter's specimen has dispersed verruca while *A. pyrenopsoides* has a contiguous areolate thallus that is much darker in color too. Unfortunately, the small Scotter collection was not any species with which we are familiar and should be re-examined in the future after the *Acarosporaceae* for Fennoscandia are revised by Martin Westberg for the Nordic Lichen Flora series.

SPECIMEN EXAMINED. – CANADA. NORTHWEST TERRITORIES: ELLESMERE ISLAND, 79° 59' N 85° 50' 46" W, 11.iv.2009, Scotter (WIS).

3. *Sarcogyne crustacea* K. Knudsen & Kocourk., **nom. nov.**

MYCOBANK MB 516741

= *Biatorella terrena* Hasse, The Bryologist 14 (1): 3 (1911),
non *Sarcogyne terrena* H. Magn. 1935.

TYPE: U.S.A. CALIFORNIA: Los Angeles Co., SAN GABRIEL MOUNTAINS, NORTH FORK OF SAN GABRIEL CANYON, SQUIRREL INN, 1300 m, on earth between stones and base of rocks, vii.1901 H.E. Hasse (FH, **HOLOTYPE**).

Biatorella terrena was described in The Bryologist (Hasse 1911) but not included in the flora of southern California (Hasse 1913) or the recent treatment of *Sarcogyne* for the Sonoran desert region (Knudsen & Standley 2008). It was only known from the holotype collected by Hasse. Neither Magnusson (1935) nor Knudsen & Standley (2008) saw the type until the first author of this paper discovered the holotype of *B. terrena* during a visit to the Farlow Herbarium (FH) in 2009. Hasse, who had not re-labeled the holotype before his death in 1915, wrote only the working name “*Biatorella fuscata*. Type” on the packet. We were in the process of describing a conspecific *Sarcogyne* but were hesitating because we had not been able to collect more substantial specimens for a type and for photography. We were happy that Hasse had already described the species.

Only one other species of terricolous *Sarcogyne* has been described, *Biatorella terrena* H. Magn. from Brazil (Magnusson 1927). Magnusson's name was illegitimate (a later homonym of *B. terrena* Hasse), which he rectified when he revised his species as *Sarcogyne terrena* H. Magn. (Magnusson 1935). Hasse's species now fits in the modern concept of *Sarcogyne* Flot. (Knudsen & Standley 2008). Because Magnusson had already used the specific epithet *terrena* in the genus *Sarcogyne*, we here propose a new name for Hasse's species, *S. crustacea*. *Sarcogyne terrena* needs a modern revision, but differs from *S. crustacea* especially in the lack of a corticated thallus, much smaller apothecia (0.2–0.3 mm in diam.) without a distinctly crenulate margin, the lack of an algal layer beneath the apothecium, and no observed pycnidia (Magnusson 1935).

The thallus of *Sarcogyne crustacea* is continuous, to 10 cm across, forming “pseudo-areoles” caused by splitting and drying of the soil separating the thallus into sections. The thallus is corticate, light beige to gray, with abundant black dots of pycnidia or nascent or abundant erumpent or sessile apothecia. The thallus is often partially or completely covered by soil particles or eroded. The cortex is up to 50 µm thick: the upper layer 5–7 µm thick, formed of the conglutinated and expanded apices of hyphae in a dark brown pigment zone, with a thin syncortex (sensu Knudsen 2008a) sealing the upper surface; the lower layer is 30–45 µm thick, hyaline, the hyphae irregularly oriented, 2–3(–4) µm in diam., septate, to subparaplectenchymatous, cells to 4 µm length. The algal layer is 10–50 µm thick, continuous, and uninterrupted, extending below the apothecia, but varying in height, algal cells mostly 7–10 µm in diam. The

medulla is grayish-white, to 100 μm tall, thoroughly mixed with soil particles, gelatinized, with branching anticlinal hyphae, hyaline, 3–4 μm in diam., thin-walled, cells 3–7 μm long or septa indistinct. The apothecia are abundant, round, 0.4–1.5 mm in diam. and sessile. The margin is black, smooth in young apothecia to knobby and crenulate in older apothecia, becoming flexuous. The disc is smooth to rugulose, epruinose, and black or red, often redder when wetted. The exciple is up to 100 μm thick of radiating hyphae mostly 2 μm in diam., septate, cells 3–5 μm long, hyaline, outer layer formed of melanized hyphal apices, dark brown to black. The hymenium is 85–130 μm high, conglutinated. The epihymenium is dark brown, 10 μm thick, paraphyses mostly 2 μm in diam., branching, and apices not expanded or barely expanded, septate, cells 5–10 μm long, with some oil drops. The asci are 60–80 \times 20 μm , with about 100 ascospores per ascus. The ascospores are simple, hyaline, mostly 4–5 \times 1.5–2.0 μm . The subhymenium is 20–30 μm thick, I+ blue turning red. The hypothecium is indistinct. The conidiomata are pycnidial, abundant, globose, ca. 100 μm in diam., wall thin, exposed ostiole area black. Conidiogenous cells 5–10 \times 1.0–2.0 μm , conidia hyaline, 4–5(–5.5) \times 0.5–1.0 μm . The species lacks secondary metabolites detectable by spot tests.

Sarcogyne crustacea is currently only known from two sites in southern California in western North America. It occurs on thin granite-derived coarse-grained and rocky soils over granite bedrock in the Santa Ana and San Jacinto Mountains in Riverside County from 940–1100 meters in chaparral areas. In the modern collections, *S. crustacea* is a component of biological soil crusts in terraces formed by *Selaginella bigelovii* Underw., a species endemic to southern California. Associated lichen species growing on soil or decaying granite include such rare Sonoran endemics such as *Acarospora thelococcoides* (Nyl.) Zahlbr., *Aspicilia glaucopsina* (Nyl. ex Hasse) Hue, and *Ramonia gyalectiformis* (Zahlbr.) Vězda as well as some more wide-spread species including *Acarospora obpallens* (Nyl. ex Hasse) Zahlbr., *Candelariella citrina* B. de Lesd., *Placidium lacinulatum* (Ach.) Breuss, *Psora californica* Timdal, *P. luridella* (Tuck.) Fink, and *Toninia aromatica* (Turner) A. Massal. The holotype of *S. crustacea* is a historical record from the San Gabriel Mountains at 1300 m in Los Angeles County; it was collected between stones and at the base of rocks on soil and is mixed with an unknown lichen and a moss.

Sarcogyne crustacea is extremely rare. Terricolous habitats in coastal southern California have been severely reduced by development, the remaining habitat often degraded by grazing, recreational use, invasive weeds, and fire (Knudsen & Magney 2006, Knudsen 2008b, Knudsen & Kocourková 2009). Consequently, biological soil crusts comprised predominately of lichens are now relatively rare although Hasse reported terricolous lichens as common at beginning of 20th century (Hasse 1913). Because of the reduction of biological

soil crusts, some species reported as common such as *Acarospora schleicheri* (Ach.) A. Massal. at beginning of 20th century (Hasse 1913) are now rare (Knudsen & Kocourková 2009). Some terricolous species possibly are already extinct like *Buellia bolacina* Tuck., a unique species known only from the holotype (Bungartz et al. 2008). Terricolous species, often rare, continue to be discovered and described from southern California, including recently several *Psora* (Timdal 2002) and *Cladonia* species (Ahti & Hammer 2002, Knudsen & Lendemer 2009), *Caloplaca obamae* K. Knudsen (Knudsen 2009), and a new *Rinodina* soon to be described by John Sheard.

Both the type of *Sarcogyne crustacea* and our best specimen from the Santa Ana Mountains are relatively poor. If better specimens are collected in the future, an epitype is needed as well as material for sequencing for phylogenetic analysis. We hope eventually to obtain good photographs of the species to present in one of our future floristic papers on the southern California lichen biota.

SPECIMEN EXAMINED. – U.S.A. CALIFORNIA: Riverside Co., SANTA ANA MOUNTAINS, ELSINORE PEAK, south-facing slope on spike moss terraces above paved road, 33° 35' 48" N 117° 20' 21" W, 1101 m, 23.vi.2009, K. Knudsen 11473 & R. Hernandez (UCR); SAN JACINTO MOUNTAINS, spike-moss terraces on slope above San Jacinto River and Hwy 74, 33° 42' 39" N 116° 46' 36" W, 940 m, thallus eroded and covered with soil, 11.xi.2003, K. Knudsen 689 (ASU, UCR).

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Literature cited

- Ahti T, Hammer S. 2002. *Cladonia*. Pp.131–158, in: Nash III TH, Ryan BD, Gries, C, and Bungartz F (eds.): Lichen Flora of the Greater Sonoran Desert Region, Vol. 1. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- Bungartz F, Nordin A, Grube M. 2008 (“2007”). *Buellia*. Pp.113–179, in: Nash III TH, Gries C, Bungartz F (eds.), Lichen Flora of the Greater Sonoran Desert Region, Vol. 3. Tempe, Arizona: Lichens Unlimited, Arizona State University.
- Esslinger TL. 2009. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: <http://www.ndsu.edu/pubweb/~esslinge/chcklst/chcklst7.htm> (first posted 1 December 1997; most recent version (#15) 27 August 2009), Fargo, North Dakota.
- Hasse HE. 1911. Additions to the lichen-flora of southern California, No. 5. The Bryologist 14: 2–4.

- Hasse HE. 1913. The lichen flora of southern California. Contributions from the United States National Herbarium 17: 1–132.
- Knudsen K. 2008a (“2007”). *Acarospora*. Pp. 1–38, in: Nash III TH, Gries C, Bungartz F. (eds.). Lichen Flora of the Greater Sonoran Region, Vol. 3. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- Knudsen K. 2008b. The Lichens on San Miguel Island, Channel Islands National Park, California: A Preliminary Checklist. *Crossosoma* 34(2): 57–75.
- Knudsen K. 2009. *Caloplaca obamae*, a new species from Santa Rosa Island, California. *Opuscula Philolichenum* 6: 37–40.
- Knudsen K, Kocourková, J. 2009. Lichens, lichenicolous and allied fungi of the Santa Monica Mountains, Part 4: Additions and corrections to the annotated checklist. *Opuscula Philolichenum* 7: 29–48.
- Knudsen K, Lendemer JC. 2009. *Cladonia maritima*, a new species in the *C. cervicornis* group from western North America. *Opuscula Philolichenum*, 6: 121–124.
- Knudsen K, Magney D. 2006. Rare lichen habitats and rare lichen species of Ventura County, California. *Opuscula Philolichenum* 3: 49–52.
- Knudsen K, Standley SM. 2008 (“2007”). *Sarcogyne*. Pp. 289–296, in: Nash TH III, Gries C, Bungartz F. (eds.). Lichen Flora of the Greater Sonoran Desert Region. Vol. 3. Lichens Unlimited, Arizona State University, Tempe.
- Lendemer JC, Kocourková J, Knudsen, K. 2009. Studies in lichens and lichenicolous fungi: more notes on taxa from North America. *Mycotaxon* 108: 491–497.
- Magnusson AH. 1926. The lichen genus *Acarospora* in New Mexico. *Meddelelser fran Göteborgs Botaniska Trädgård* 2: 71–82.
- Magnusson AH. 1927. Descriptions of new or not properly defined lichens. *Meddelelser fran Göteborgs Botaniska Trädgård* 3: 11–23.
- Magnusson AH. 1929. A monograph of the genus *Acarospora*. *Kungl. Svenska Vetenskaps-Akademiens Handlingar*, Stockholm, ser. 3, 7(4): 1–400.
- Magnusson AH. 1930. The lichen genus *Acarospora* in New Mexico. *Meddelelser fran Göteborgs Botaniska Trädgård* 5: 55–72.
- Magnusson AH. 1935. On the species of *Biatorella* and *Sarcogyne* in America. *Annales de Cryptogamie Exotique*, 7: 115–145.
- Timdal E. 2002. *Psora*. Pp. 418–430, in: Nash III TH, Ryan BD, Gries C and Bungartz F. (eds.): Lichen Flora of the Greater Sonoran Desert Region. Vol. 1. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- Thomson JW, Scotter GW. 1985. Lichens of Eastern Axel Heiberg Island and the Fosheim Peninsula, Ellesmere Island, Northwest Territories. *Canadian Field-Naturalist* 99: 179–187.

Dictyostelids from Ukraine 2: two new records of *Dictyostelium*

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Abstract —Two species of *Dictyostelium* are reported for the first time in Ukraine. *D. magnum* and *D. brefeldianum* were isolated from forest soil and leaf litter collected from Yalta, Crimea, Ukraine. The descriptions and photographs of their important life cycle stages are provided based on Ukraine materials. The specimens have been deposited in the Herbarium of Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

Key words —cellular slime mold, taxonomy

Introduction

Dictyostelid cellular slime molds, or dictyostelids, are a relatively small but quite remarkable group of organisms (Raper 1984). In the life cycle, they share the protozoan characteristics of myxamoebae and pseudoplasmodia and fungal characteristics of fructifications and spores. Since Oskar Brefeld (1869) reported the first species of cellular slime mold and named *D. mucoroides* Bref., approximately 60 *Dictyostelium* species have been described (Kirk et al. 2008). *Dictyostelium* is the oldest and largest dictyostelid genus. The present paper is the second report of dictyostelids in Ukraine since *D. implicatum* H. Hagiw. and *D. tenue* Cavender, Raper & Norberg were first isolated from this country (Liu & Li 2010).

Materials and methods

The soil and leaf litter samples were collected during October 2008 in Baydar Valley, Eski-Kermen and Angara Valley, Yalta, Crimea, Ukraine. The samples were refrigerated at 4°C and isolated according to He & Li (2008). Five agar plates were established and incubated at 23°C with 12 h light and 12 h darkness.

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The locations of each early aggregating clone and sorocarps were marked. The life cycle stages of cell aggregation, pseudoplasmodium, and sorocarp were observed under a Nikon dissecting microscope (SMZ1500) with 0.75–11.25× range (10× oculars). Spores, stalks, and sorocarps were measured using a Nikon light microscope (SMZ1000) with 10× oculars and 10, 40, and 100× (oil) objectives. Photographs were taken with a CANON S70 camera.

Results

1. *Dictyostelium magnum* H. Hagiw., Bull. Natn. Sci. Mus., Tokyo, Ser. B, 9(4): 155 (1983).

FIG. 1 A–E

Sorocarps solitary, usually unbranched, phototropic, sometimes prostrate. Sorophores colorless, sinuous, 0.7–11.0(–60) mm long, usually tapering from bases to tips, bases expanded and stout, tips blunt. Sori white, globose, 30–500 µm diam. Spores hyaline, elliptical, usually $6.5\text{--}8.8 \times 3.5\text{--}5.0$ µm, without polar granules. Cell aggregations radiate. Pseudoplasmodia not migrating without sorophore formation, usually producing single sorogens. Myxamoebae irregular or triangular in the direction of movement.

SPECIMENS EXAMINED: MR041. Isolated from forest soil collected by the authors in Angara Valley (10 Oct. 2008, S0299-2), Yalta, Crimea, Ukraine in 2009. Deposited at the Herbarium of Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

COMMENTS—*Dictyostelium magnum* is a gigantic species. It is most likely to be confused with three other very large species — *D. firmibasis* H. Hagiw. (Hagiwara 1971), *D. giganteum* B.N. Singh (Raper 1984), and *D. septentrionale* Cavender (Raper 1984). The spores of *D. magnum* are, however, stouter and shorter than those of *D. firmibasis* ($6.2\text{--}9.2 \times 2.7\text{--}4.0$ µm). Hagiwara et al. (1992) suggested *D. magnum*, isolated from soil samples collected in Taiwan, is probably synonymous with *D. giganteum*, and later mating tests by Hagiwara (1992) support this synonymy. Our research shows that these two species differ in spore and sorocarp sizes. The spores of *D. magnum* ($6.5\text{--}8.8 \times 3.5\text{--}5.0$ µm) are bigger than those of *D. giganteum* ($5.5\text{--}7.2 \times 2.1\text{--}3.9$ µm). The sorocarps of *D. magnum* are somewhat smaller [0.7–11.0(–60) mm] than those of *D. giganteum* (0.5–70 mm). Such differences support their separation as two distinct species. In the laboratory, *D. septentrionale* itself needs lower temperature conditions (12–19 °C) and fails to fruit at higher temperatures (Raper 1984), whereas *D. magnum* could be cultured at 20–23 °C.

2. *Dictyostelium brefeldianum* H. Hagiw., Bull. Natn. Sci. Mus., Tokyo, Ser. B, 10(1): 39 (1984).

FIG. 1 F–K

Sorocarps solitary, usually unbranched, phototropic, prostrate. Sorophores colorless, sinuous, 0.6–4.5(10.5) mm long, tapering from bases to tips, usually

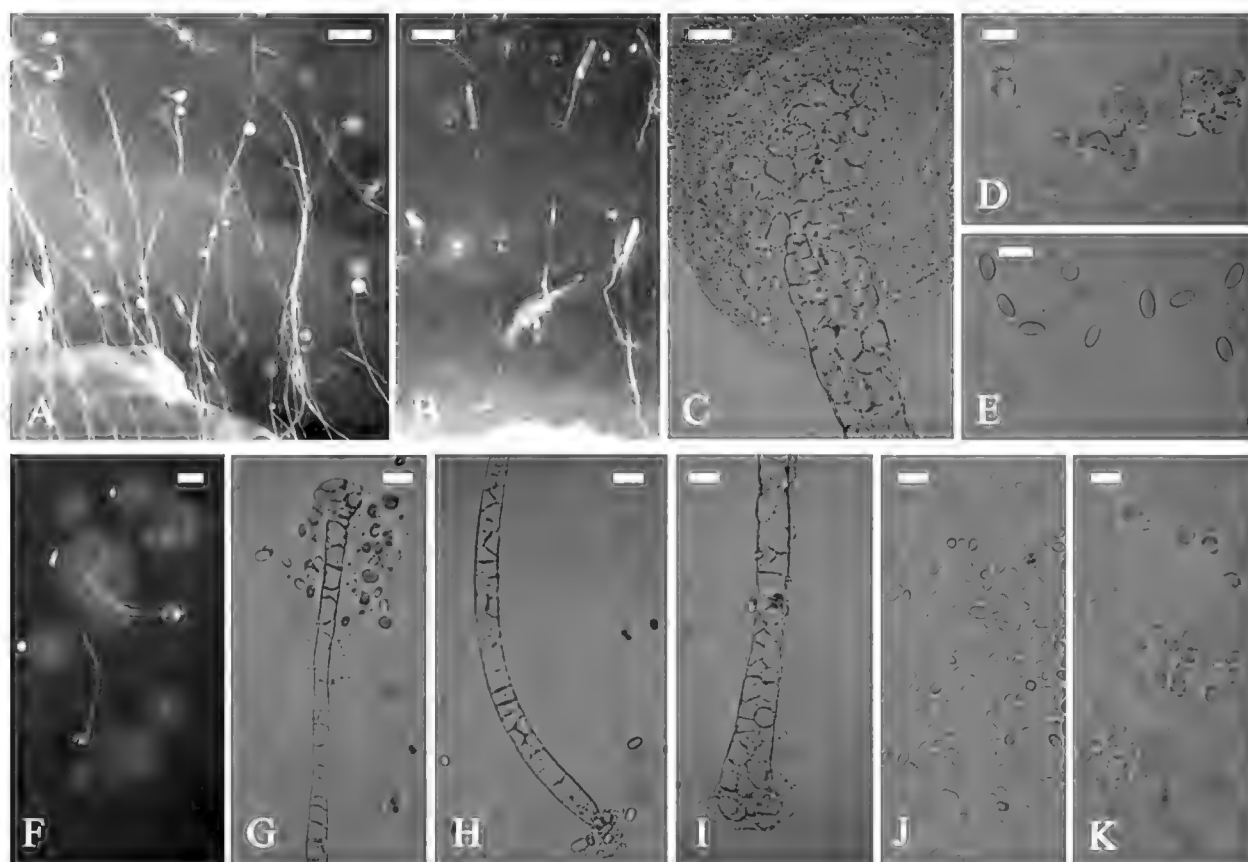


FIGURE 1. A–E, *Dictyostelium magnum*; F–K, *D. brefeldianum*. A, F, Sorocarps (bar = 0.5 mm); B, Pseudoplasmodia (bar = 0.3 mm); C, H, I, Sorophore bases (bar = 15 μ m); D, K, Myxamoebae (bar = 15 μ m); E, J, Spores (bar = 15 μ m); G, Sorophore tips (bar = 15 μ m).

consisting of one tier of cells except for the bases and tips, bases conical or round, tips capitate. Sori white, globose, 25–230(280) μ m diam. Spores hyaline, oblong, mostly $5.3\text{--}7.3 \times 3.0\text{--}4.0$ μ m, without polar granules, sometimes with irregular granules. Cell aggregations radiate. Pseudoplasmodia not migrating without sorophore formation, usually producing single sorogens. Myxamoebae irregular or triangular in the direction of movement.

SPECIMENS EXAMINED: MR043. Isolated from the mixture of forest soil and leaf litter collected in Baydar Valley (8 Oct. 2008, S0276-5) and forest soil collected in Angara Valley (10 Oct. 2008, S0308-3), Yalta, Crimea, Ukraine in 2009. Deposited at the Herbarium of Mycological Institute of Jilin Agricultural University (HMJAU), Changchun, China.

COMMENTS—*Dictyostelium brefeldianum* is a medium-sized species that is often prostrate and strongly phototropic. Its macroscopic characteristics are similar to the closely related species, *D. implicatum* H. Hagiw. (Hagiwara 1984a) and *D. arabicum* H. Hagiw. (Hagiwara 1991). However, it differs from those similar species in its capitate sorophore tips and oblong spores lacking polar granules. Other species with capitate tips include *D. crassicaule* H. Hagiw. (Hagiwara 1984b) and *D. septentrionale* (Raper 1984), which have stout and thick sorophores, *D. purpureum* Olive (Raper 1984) and *D. mexicanum* Cavender et al. (Raper 1984), which produce colored sorocarps, *D. longosporum* H. Hagiw.

(Hagiwara 1983a) with longer spores, and *D. capitatum* H. Hagiw. (Hagiwara 1983b) with smaller spores. Furthermore, *D. brefeldianum* is cosmopolitan and has already been reported in America, Canada, Germany, England, France, Denmark, Switzerland, Japan, New Guinea, Nepal, and Uganda (Hagiwara 1984). However, this is the first time *D. brefeldianum* has been isolated from samples from Ukraine.

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Literature cited

- Brefeld O. 1869. *Dictyostelium mucoroides*. Ein neuer Organismus und der Verwandtschaft der Myxomyceten. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 7: 85–107, pls. 1–3.
- Hagiwara H. 1971. The *Acrasiales* in Japan. I. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 14: 351–366.
- Hagiwara H. 1983a. Four new species of dictyostelid cellular slime molds from Nepal. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 9(4): 149–158.
- Hagiwara H. 1983b. The *Acrasiales* in Japan. VI.. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 9(2): 45–49.
- Hagiwara H. 1984a. Review of *Dictyostelium mucoroides* Brefeld and *D. sphaerocephalum* (Oud.) Sacc. et March. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 10(1): 27–41.
- Hagiwara H. 1984b. The *Acrasiales* in Japan. VII. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 10(2): 63–71.
- Hagiwara H. 1991. A new species and some new records of dictyostelid cellular slime molds from Oman. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 17(3): 109–121.
- Hagiwara H. 1992. Taxonomic studies in dictyostelids. 1. *Dictyostelium giganteum* Singh, *D. firmibasis* Hagiwara and *D. magnum* Hagiwara. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 18(3): 101–107.
- Hagiwara H, Chien CY, Yeh ZY. 1992. Dictyostelid cellular slime molds of Taiwan. Bull. Natn. Sci. Mus., Tokyo, Ser. B. 18(2): 39–52.
- He XL, Li Y. 2008. A new species of *Dictyostelium*. Mycotaxon 106: 379–383.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Dictionary of the Fungi, 10th edition. CAB International, Wallingford, UK.
- Liu P, Li Y. 2010. Dictyostelids from Ukraine 1: two new records of *Dictyostelium*. Mycotaxon 111: 275–278.
- Raper KB. 1984. The Dictyostelids. Princeton, New Jersey, USA.

Five new records for the lichen biota of Turkey

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Abstract—Five lichen species (*Bacidia sipmanii*, *Buellia caldesiana*, *Byssoloma leucoblepharum*, *Collema occultatum* and *Porina lectissima*) are reported for the first time from Turkey. For each a short description is presented.

Key Words —biodiversity, Giresun, Konakönü

Introduction

Large parts of Turkey are still very insufficiently explored with regard to their lichen biota. In the last four years, however, many new lichen species have been reported for Turkey (e.g. Aslan et al. 2005, Breuss & John 2004, Candan & Özdemir Türk 2008, Çobanoğlu et al. 2008, Halıcı et al. 2007, Kınalıoğlu 2009a,b, Tufan et al. 2005, Yazıcı 2007 et al.).

For Trabzon province in the eastern Black Sea region 518 species have been reported (John 1995 [and references therein], 1999, 2000, 2002; John & Breuss 2004; John & Nimis 1998; John et al. 2000; Kınalıoğlu 2007b, 2008; Kınalıoğlu & Engin 2004; Yazıcı 1996, 1999, 2006; Yazıcı & Aslan 2002, 2005) and for Giresun province only 431 species (Aslan et al. 2002; Aslan & Yazıcı 2006; Duman & Yurdakulol 2007; Halıcı & Şenkardeşler 2009; John & Breuss 2004; Kınalıoğlu 2005, 2006, 2008, 2009; Kınalıoğlu & Engin 2004; Küçük 1990; Özgen et al. 2003; Steiner 1909; Süleyman et al. 2002; Yazıcı 2006; Yazıcı & Aptroot 2008). The present paper is a further contribution to the lichen biota of these provinces.

Materials and methods

Samples were collected in Trabzon and Giresun provinces between 2006 and 2008. They were identified with various lichen guides (e.g. Brodo et al. 2001, Purvis et al. 1992, Wirth 1995). The specimens are stored in the herbarium

of the Faculty of Science and Arts, Giresun University, Giresun, Turkey; with some duplicates in herb. H. Sipman. The accession numbers of the collections are given in parentheses after the locality details.

Taxonomy

Bacidia sipmanii M. Brand et al.

A detailed description is provided by Brand et al. (2009).

The Turkish specimen was collected from siliceous rock. Thallus crustose, thin, small, areolate, grey-brown. Apothecia 0.1–0.9 mm diam., often few; disc slightly convex, light brown to dark brown or blackish brown, with a darker margin. Hymenium colourless, 43–60 μm tall; paraphyses simple, apices slightly swollen to 2 μm . Ascospores colourless, 25–45 \times 1.5–2.5 μm , 4–8 celled. Conidia 20–28 \times 0.8–0.9 μm , strongly curved. Thallus C–, K–, KC–, PD–.

Known from England, Ireland, France, Italy, and the Canary Islands on siliceous maritime rocks in the xeric supralittoral zone in crevices and underhangs, on vertical shaded volcanic outcrops and rarely on soil (Brand et al. 2009).

SPECIMEN EXAMINED: Trabzon, Araklı, Konakönü place, sea shore, 40°57'17"N, 40°02'56"E, 3 m, 12 Aug. 2006, on siliceous rock, det. H. Sipman, (Kınalıoğlu 1568).

Buellia caldesiana Bagl.

A detailed description is provided by Scheidegger (1993).

The Turkish specimen was collected from siliceous rock. Thallus light yellowish or dirty white, crustose, rimose to areolate. Apothecia 0.3–0.8 mm diam, immarginate to thinly marginate; disc black, plane, weakly whitish pruinose. Hymenium 60–75 μm tall; epithecium olive. Hypothecium dark brownish. Asci *Lecanora*-type. Ascospores brown, 1-septate, oblong, 12–13 \times 6.5–7 μm . Conidia not observed. Thallus C + orange.

Known from Europe on more or less calcareous rocks (Scheidegger 1993).

SPECIMEN EXAMINED: Giresun, Center, SE slope of Gedikkaya hill, 40°54'35"N, 38°24'48"E, 190 m, 10 June 2006, on siliceous rock, det. H. Sipman, (Kınalıoğlu 1544).

Byssoloma leucoblepharum (Nyl.) Vain.

A detailed description is provided by Purvis et al. (1992).

The Turkish specimen was collected from *Erica arborea*. Thallus crustose, brownish-greyish, mostly thin. Apothecia 0.3–1.1 mm diam, flat; disc dark orange-brown, with a white-grey woolly margin spreading onto the thallus surface. Hypothecium brownish. Ascospores 10–17 \times 2.5–4 diam., 4-celled, colourless. Thallus C–, K–, KC–, PD–.

Widely distributed in tropical and subtropical regions, extending to the temperate zone, on bark and leaves (Purvis et al. 1992).

SPECIMEN EXAMINED: Trabzon, Araklı, Konakönü place, 40°57'44"N, 40°02'32"E, 8 m, 12 Aug. 2006, on *Erica arborea*, det. H. Sipman, (Kınalıoğlu 1690).

Collema occultatum Bagl.

A detailed description is provided by Purvis et al. (1992) and Zedda et al. (2009: 157).

The Turkish specimen was collected from *Fraxinus* sp. Thallus small, dark brownish, mostly scattered lobes, subcrustose to minutely globose or with foliose lobes. Apothecia dispersed or aggregated; disc 0.2–0.4 mm diam., flat to convex, brown, pink when young and black when mature. Ascospores 13–21.5 × 9–15 µm, cuboid-oblong, submuriform.

Known from Europe (especially Mediterranean region), North Africa and North America, on bark. (Purvis et al. 1992, Zedda et al. 2009).

SPECIMEN EXAMINED: Trabzon, Araklı, Konakönü place, 40°57'44"N, 40°02'32"E, 8 m, 12 Aug. 2006, on *Fraxinus* sp., det. H. Sipman, (Kınalıoğlu 1694).

Porina lectissima (Fr.) Zahlbr.

A detailed description is provided by Purvis et al. (1992).

The Turkish specimen was collected from siliceous rock. Thallus brownish green, irregularly cracked, thin. Perithecia reddish dark brown or partly pinkish, projecting above the thallus surface, 0.2–0.4 mm diam. Ascospores 3-septate when mature, fusiform, colourless, 20–32 × 4–8 µm. Asci 8-spored, thin walled.

Known from Europe and North America on damp siliceous rock (Purvis et al. 1992).

SPECIMEN EXAMINED: Trabzon, Araklı, Konakönü place, sea shore, 40°57'17"N, 40°02'56"E, 3 m, 12 Aug. 2006, on siliceous rock, det. H. Sipman, (Kınalıoğlu 1569).

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Literature cited

- Aslan A, Aptroot A, Yazıcı K. 2002. New lichens for Turkey. *Mycotaxon* 84: 227–280.
 Aslan A, Vezda A, Yazıcı K, Karagöz Y. 2005. New foliicolous lichen records for the lichen flora of Turkey. *Cryptogamie, Mycologie* 26(1): 61–66.
 Aslan A, Yazıcı K. 2006. Contribution to the lichen flora of Giresun province of Turkey. *Acta Botanica Hungarica* 48(3–4): 231–245.

- Brand M, Coppins BJ, van den Boom PPG, Sérusiaux E. 2009. Further data on the lichen genus *Bacidia* s.l. in the Canary Islands and Western Europe, with descriptions of two new species. *Bibliotheca Lichenologica*, 99: 83–93.
- Breuss O, John V. 2004. New and interesting records of lichens from Turkey. *Österr. Z. Pilzk.* 13: 281–294.
- Brodo IM, Sharnoff SD, Sharnoff S. 2001. *Lichens of North America*. Yale University Press, New Haven and London.
- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). *Mycotaxon* 105: 19–22.
- Çobanoğlu G, Sevgi E, Sevgi O. 2008. Epiphytic lichen mycota of, and new records from, Şerif Yüksel research forest, Bolu, Turkey. *Mycologia Balcanica* 5: 135–140.
- Duman C, Yurdakulol E. 2007. Lichen records from Sarıçiçek Mountain in southern Giresun province, Turkey. *Turk J. Bot.* 31: 357–365.
- Halıcı MG, Candan M, Özdemir Türk A. 2007. New records of lichenicolous and lichenized fungi from Turkey. *Mycotaxon* 100: 255–260.
- Halıcı MG, Şenkardeşler A. 2009. Giresun için yeni kayıt: *Phaeosporobolus usneae*. *Türk liken toluluğu bülteni* 7: 11–12.
- John V. 1995. *Flechten der Türkei IV. Ergänzungen zum die Türkei betreffende lichenologische Schrifttum*. Neunkirchener Druckerei und Verlag, Neunkirchen, Germany.
- John V. 1999. *Lichenes Anatolici Exsiccati*. Fasc. 1–3 (No: 1–75). *Arnoldia* 16: 1–41.
- John V. 2000. *Lichenes Anatolici Exsiccati*. Fasc. 4–5 (No: 76–125). *Arnoldia* 19: 1–27.
- John V. 2002. *Lichenes Anatolici Exsiccati*. Fasc. 6–7 (No: 126–175). *Arnoldia* 21: 1–28.
- John V, Breuss O. 2004. *Flechten der östlichen Schwarzmeer-Region in der Türkei (BLAM Exkursion 1997)*. *Herzogia* 17: 137–156.
- John V, Nimis PL. 1998. Lichen flora of Amanos mountain and the province of Hatay. *Turkish Journal of Botany* 22: 257–267.
- John V, Seaward MRD, Beaty JW. 2000. A neglected lichen collection from Turkey: Berkhamsted School Expedition 1971. *Turkish Journal of Botany* 24: 239–248.
- Kınalıoğlu K. 2005. Lichens of Giresun district, Giresun province, Turkey. *Turkish Journal of Botany* 29: 417–423.
- Kınalıoğlu K. 2006. Lichens of Keşap district (Giresun, Turkey). *Acta Botanica Hungarica* 48(12): 65–76.
- Kınalıoğlu K. 2007b. Lichens of the alpine region in Araklı–Sürmene district, Trabzon province (Turkey). *Cryptogamie, Mycologie* 28 (2): 159–168.
- Kınalıoğlu K. 2008. Three new records for the lichen biota of Turkey. *Mycotaxon* 103: 123–126.
- Kınalıoğlu K. 2009a. Lichens from the Amasya, Corum, and Tokat regions of Turkey. *Mycotaxon* 109: 181–184.
- Kınalıoğlu K. 2009b. Additional lichen records from Giresun province, Turkey. *Mycotaxon*, 109: 137–140.
- Kınalıoğlu K, Engin A. 2004. Bülbülan (Artvin), Ayder, Anzer (Rize), Kalecik (Trabzon) ve Kümbet (Giresun) yaylalarının likenleri. *Ot Sistematiik Botanik Dergisi* 11(2): 167–190.
- Küçük M. 1990. Giresun Adası'nın floristik yapısı. *Ormancılık Araştırma Enstitüsü Yayınları* 36(2): 58.
- Özgen U, Aslan A, Terzi Z. 2003. Phytochemical screening of some lichen species collected from Giresun province. I. International Congress on the Chemistry of Natural Products (ICNP) 16–19 October, Trabzon, Türkiye.

- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The lichen flora of Great Britain and Ireland. Natural History Museum & British Lichen Society, London.
- Scheidegger C. 1993. A revision of European saxicolous species of the genus *Buellia* De Not. and formerly included genera. *Lichenologist* 25(4): 315–364.
- Steiner J. 1909. Lichenes. In: Handel-Mazzetti HRE: Ergebnisse einer botanischen Reise das Pontische Randgebirge im Sandschak Trapezunt. *Annal. Naturhist. Hofmus. Wien* 23: 107–123.
- Süleyman H, Yıldırım D, Aslan A, Göçer F, Gepdiremen A, Güvenalp Z. 2002. An investigation of the antiinflammatory effects of an extract from *Cladonia rangiformis* Hoffm. *Biol. and Pharm. Bull.* 25: 10–13.
- Tufan Ö, Sümbül H, Özdemir Türk, A. 2005. The lichen flora of the Termessos National Park in Southwestern Turkey. *Mycotaxon* 94: 43–46.
- Wirth V. 1995. Die Flechten Baden-Württembergs. Ulmer, Stuttgart.
- Yazıcı K. 1996. Altındere Vadisi Milli Parkı liken florası. *Turkish Journal of Botany* 20: 263–265.
- Yazıcı K. 1999. Lichen flora of Trabzon. *Turkish Journal of Botany* 23: 97–112.
- Yazıcı K. 2006. Four new lichens from Turkey. *Myxotaxon* 95: 315–318.
- Yazıcı K, Aptroot A, Aslan A. 2007. Lichen biota of Zonguldak, Turkey. *Mycotaxon* 102: 257–260.
- Yazıcı K, Aptroot A. 2008. Corticolous lichens of the city of Giresun with descriptions of four species new to Turkey. *Mycotaxon* 105: 95–104.
- Yazıcı K, Aslan A. 2002. New records for the lichen flora of Turkey. *Turkish Journal of Botany* 26: 117–118.
- Yazıcı K, Aslan A. 2005. Six new lichen records from Turkey. *Mycotaxon* 93: 359–363.
- Zedda L, Schultz M, Rambold G. 2009. Diversity of epiphytic lichens in the savannah biome of Namibia. *Herzogia* 22: 153–164.

Two new species of the *Parmotrema subrugatum* group from the coast of São Paulo State, southeastern Brazil

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Abstract — During a survey of the *Parmeliaceae* in natural ecosystems and urbanized coastal areas of southeastern Brazil, two new *Parmotrema* species containing alecronic acid were discovered: *P. hyperlaciniatulum* and *P. restingense*. These species are described and compared to *P. subrugatum*.

Key words — *Parmotrema lacinulatulum*, *Parmotrema maraense*, *Parmotrema wainioi*

Introduction

The genus *Parmotrema* A. Massal. is characterized by lobes with broad rotund apices and naked lower margins, the absence of pseudocyphellae, the frequent occurrence of marginal cilia, simple rhizines, and thick-walled, ellipsoid ascospores (Brodo et al. 2001, Nash & Elix 2002). More than 300 species are known worldwide (Nash & Elix 2002), and about one third of them occur in Brazil.

Two new species containing alecronic acid are described in the present paper. These species were discovered by the authors during research on the broad-lobed species of *Parmeliaceae* at the coast in São Paulo State, Brazil (Benatti 2005), primarily situated between the municipalities of Ubatuba (23°02'S, 45°04'W) and Itanhaém (24°11'S, 46°47'W). This region includes urbanized areas and rocky shores, as well as mangrove and restinga forests as the predominant vegetation types.

The most common species of *Parmotrema* producing alectoronic acid in Brazil can be separated into two characteristic subgroups: (1) the *P. wainioi* group, with ascospores ca. 15–25 µm, filiform conidia over 6 µm long and abundant long cilia and (2), the *P. subrugatum* group, with larger ascospores 25–40 µm long, unciform conidia up to 6 µm long and shorter, less abundant cilia.

Both of the new species lack vegetative propagules, are corticolous in coastal mangrove or restinga forests, and belong to the *P. subrugatum* subgroup. Although we have included substantive information about the new species, more detailed morphological and chemical comparisons with other somewhat similar species can be found in Benatti (2005).

Material and methods

Specimens were distinguished by morphological characters using standard stereoscopic and light microscopes. Anatomical sections, including those of apothecia and pycnidia, were made with a razor blade by hand. The chemical constituents were checked by spot tests with potassium hydroxide (K), sodium hypochlorite (C) and *para*-phenylenediamine (P), and also examined under UV light (360 nm). Chemical constituents were identified by thin-layer chromatography (TLC) using solvent C (Bungartz 2001), high performance liquid chromatography (HPLC) (Elix et al. 2003) and comparison with authentic samples.

Since we had encountered problems dealing with the many morphological terms present in the literature, we specify here that lacinules represent adventitious, ribbon-like secondary outgrowths from the primary lobe margins. Lobules are similar, but short and rounded.

The diagnosis for each taxon refers exclusively to holotype characters and the English descriptions and comments to all the material studied.

The species

***Parmotrema hyperlaciniatulum* Benatti, Marcelli & Elix, sp. nov.**

FIG. 1

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Species cum thallo simili Parmotrematis lacinulatuli sed magis robusto et crasso, lobis angustis laciniatis demum lacinulatis, cortex superior continuus et emaculatus, ciliis parvis, conidiis minoribus et unciformibus differt. Atranorinam, chloroatranorinam, acidum alectoronicum, acidum α -collatolicum, acidum β -alectoronicum, acidum β -collatolicum, acidum dehydrocollatolicum, acidum dehydroalectoronicum, methyl pseudoalectoronatum, et methyl pseudo- α -collatolatum continens.

HOLOTYPE: Brazil, São Paulo State, Municipality of Itanhaém, Padre Manoel da Nóbrega Highway (SP-55) Km 108, at the crossing point with the Itanhaém River, mangroves by the side of the highway at the right margin of the river, 24°10'48.7"S, 46°48'07.1"W, 1 m alt., on trunk of *Rhizophora mangle* L., leg. M.P. Marcelli & L.R. Fontes 1670, 01-X-1979 (SP).

THALLUS up to 14 cm wide, subcoriaceous to coriaceous, corticolous, grayish green but becoming dark gray in the herbarium, primarily lobed to sublobed, ultimately developing dense secondary laciniae; LOBES irregularly branched, 1.5–4.0(–5.0) mm wide, primary lobes contiguous to \pm imbricate, adnate to loosely adnate, secondary lacinules ascending, unattached, eventually twisted and subcanaliculate; APICES \pm plane to subconcave, subrotund; MARGIN smooth to irregularly dissected, plane to \pm ascending, weakly undulate in part, entire to incised, ciliate. UPPER SURFACE continuous to weakly and irregularly cracked, smooth to subrugose, sometimes with verrucae becoming papillose; MACULAE weak to distinct, linear, laminal, more obvious at the distal parts, sometimes developing fissures; LACINULES linear and long, regularly spreading from margins, abundant at the thallus center, simple then dichotomously or irregularly branched, subcanaliculate to canaliculate, $0.2\text{--}15.0(–30.0) \times 0.2\text{--}0.9(–1.1)$ mm, truncate, crowded, often covering parts of the upper surface, sometimes with papillose verrucae, underside cream or black. SORALIA, PUSTULES and ISIDIA absent. CILIA black, simple or rarely furcate, $0.1\text{--}1.7(–2.4) \times \text{ca. } 0.05$ mm, frequent along the margins of the lobes and lacinules. MEDULLA white, with orange pigmented spots often present in the lower portion. LOWER SURFACE black, shiny, smooth to rugose, unevenly papillate; MARGINAL ZONE shiny to opaque, usually pale brown but soon turning cream colored at the start of lacinules growth, smooth to rugose, unevenly papillate $0.5\text{--}4.5(–6.0)$ mm wide, naked; RHIZINES black, simple, sometimes agglutinated, $0.20\text{--}0.70(–1.3) \times 0.05\text{--}0.15$ mm, sparse or frequent, grouped. APOTHECIA submarginal to subterminal, common, often originating on the lacinules, concave, $0.3\text{--}9.2$ mm wide, substipitate, margins smooth to crenate or dentate-lacinulate, usually eciliate or rarely with scarce cilia, amphithecia and stipe smooth but becoming rugose with age; DISC brown, epruinose, imperforate; ASCOSPORES ellipsoid, $(22.5\text{--})24.5\text{--}38.0(–40.0) \times 14.0\text{--}21.5$ μm , epispore $(2.5\text{--})3.0\text{--}3.5$ μm wide. PYCNIDIA submarginal, common, abundant on the lacinules, with brown or black ostioles; CONIDIA short unciform, $4.0\text{--}5.0 \times \text{ca. } 1.0$ μm .

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C–, KC+ rose, P–, UV+ bluish green, and a K+ dark reddish pigment in the lower portions.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary alectoronic acid (major), α -collatolic acid (major), β -alectoronic acid (minor), β -collatolic acid (minor), dehydrocollatolic acid (minor), dehydroalectoronic acid (trace), methyl pseudoalectoronate (trace) and methyl pseudo- α -collatolate (trace).

PARATYPES: Brazil, São Paulo State, Municipality of Itanhaém, Padre Manoel da Nóbrega Highway (SP-55) Km 108, at the crossing point with the Itanhaém River, mangrove by the highway's side at the river's right margin, $24^{\circ}10'48.7''\text{S}$, $46^{\circ}48'07.1''\text{W}$, 1 m alt., on trunk of *Rhizophora mangle*, leg. M.P. Marcelli & L.R. Fontes 1669, 10-I-1979 (SP); idem,

on tree trunk, leg. M.P. Marcelli & A. Mathey 1672, 05-VIII-1981 (SP); idem, on trunk of *Laguncularia racemosa* C.F. Gaertn., leg. M.P. Marcelli & L.R. Fontes 2386, 01-IV-1988 (B); idem, on tree trunk, leg. M.P. Marcelli, B. Marbach & C.H. Ribeiro 29380, 21-VIII-1995 (G).

COMMENTS: This species is characterized by the absence of vegetative propagules, the narrow lobes which become laciniate and subcanaliculate and develop dense lacinules at the apices and margins, the substipitate apothecia with dentate-lacinulate, eciliate or sparsely ciliate margins, and pale brown lower margins which turn cream at the beginning of lacinule formation. An orange K+ dark red pigment is often present at the lower portions of the medulla, but this was not detected with HPLC.

The verrucae (or papillae) on the upper surface of the lobes and the lacinules resemble stout isidia, but lack a constricted base present in true isidia. They often support pycnidia.

Parmotrema hyperlaciniatulum differs from *P. subrugatum* and other species of this complex by the short, weakly inflated apothecia stipes (longer and markedly inflated in *P. subrugatum*) although the stipes do appear larger when developing on subcanaliculate lobe apices. Although most of the apothecia are eciliate, we noted that some apothecia in each specimen examined had a few poorly developed cilia.

Parmotrema lacinulatulum Krog from East Africa is superficially similar and we initially thought that the present material might represent this species. However *P. lacinulatulum* has a thinner and more fragile thallus, much broader lobes (5.0–8.0 mm), longer cilia (3.0–4.0 mm), a more continuous, emaculate upper cortex, longer sublageniform conidia (7.0–7.5 μm) and lacks a K+ orange pigment in the medulla (Krog 1991).

The lacinules of *P. hyperlaciniatulum* often cover large portions of the upper surface and extend to several centimeters long. With the aging of the thallus, the older, primary lobes die and disintegrate, but the subcanaliculate lacinules continue to grow and resemble somewhat small specimens of *Everniastrum*.

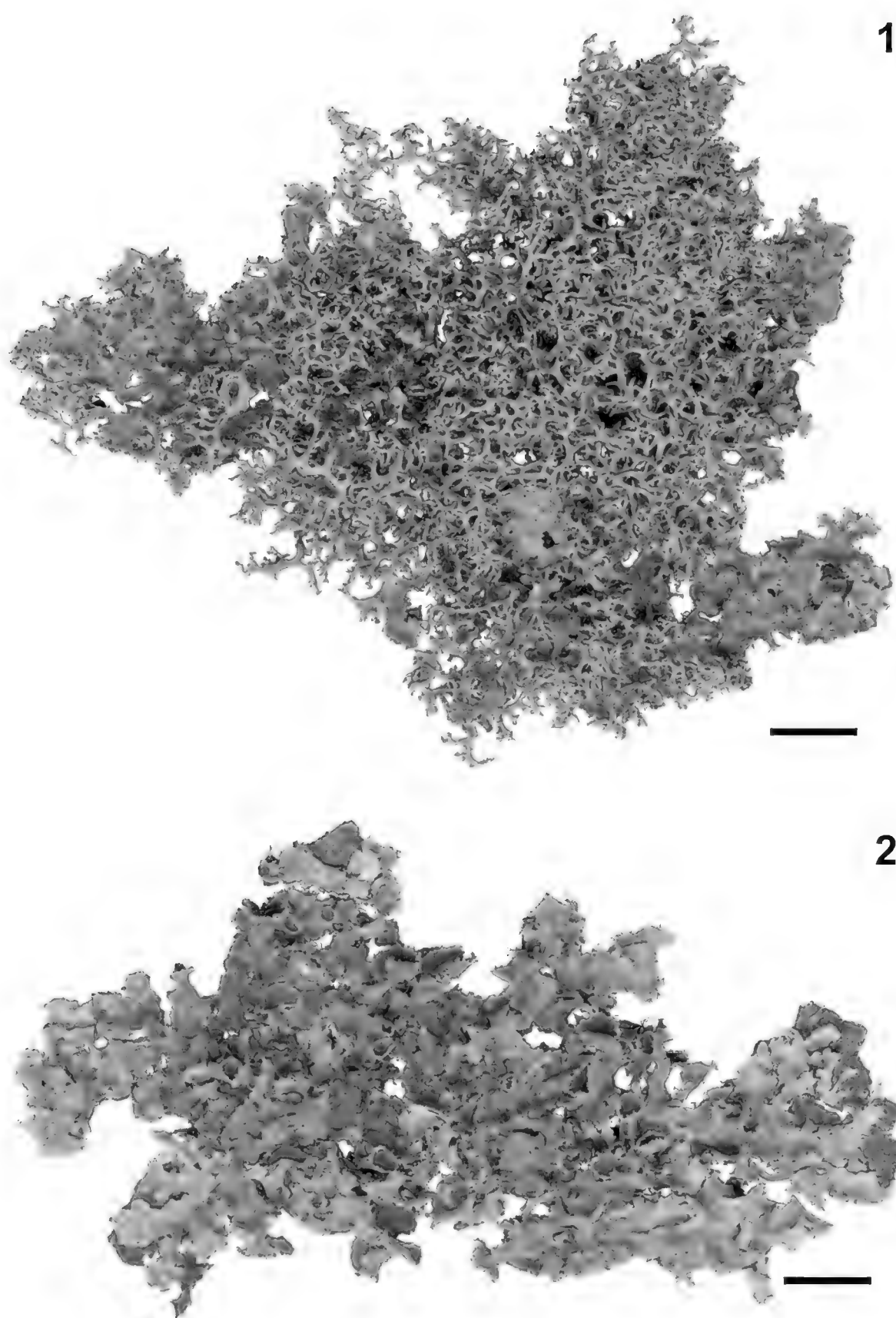
The mature thalli of *P. hyperlaciniatulum* must be collected and handled with care; otherwise, they may crumble since the older parts that keep the terminal parts together are often no longer present. This species is named after its habit, where the lobes gradually change their form, becoming laciniate and ultimately densely lacinulate.

***Parmotrema restingense* Marcelli, Benatti & Elix, sp. nov.**

FIG. 2

MYCOBANK MB 516773

Species cum thallo simili Parmotrematis subrugati sed lobis angustatis, margine irregulariter sublacinulatis, margine inferior non continuus albida et apothecia laevigata vel ex parte lacinulata denticulata, eciliata differt. Atranorinam, chloroatranorinam, acidum alectoronicum, acidum α -collatolicum, acidum β -alectoronicum, acidum β -collatolicum, methyl pseudoalectoronatum, et methyl pseudo- α -collatolatum continens.



FIGURES 1–2. 1. The holotype of *P. hyperlaciniatulum*.
2. The holotype of *P. restingense*.
Bar = 1 cm.

HOLOTYPE: *Brazil, São Paulo State, Municipality of Cananéia, near the continental raft port to Cananéia, mangrove at the roadside, 24°59'10.2"S, 47°57'06.1"W, 1 m alt., on tree trunk, leg. M.P. Marcelli & J. Vieira Filho 1593, 23-XII-1979 (SP).*

THALLUS up to 16.0 cm wide, submembranaceous to subcoriaceous, ramulicolous or corticolous, pale greenish gray becoming darker in the herbarium, lobate to sublobate. LOBES (1.5–)2.5–6.0(–9.0) mm wide, irregularly branched, contiguous to crowded, adnate, ascending when bearing apothecia, loosely attached; APICES \pm plane to subconvex and involute, subrotund to irregular; MARGIN smooth near the apices, turning subcrenate or irregular, \pm flat to ascending or subundulate, involute or revolute, entire to irregularly incised, partially dentate-sublacinulate, ciliate. UPPER SURFACE continuous but becoming irregularly cracked with age, smooth to subrugose; MACULAE weak to distinct, punctiform or sometimes aggregate and linear, laminal but more frequently appearing on the amphithecia and apothecial stipes. Adventitious LACINULES generally sparse, very short, irregularly distributed along the lobe margins but occasionally intermixed with some small irregular lobules, simple or irregular, flat, 0.3–1.4(–2.5) \times 0.2–0.7 mm, truncate or acute, underside concolorous with the lower margin or cream on lobes with apothecia. CILIA black, simple to furcate or rarely irregular, 0.2–2.8 \times ca. 0.05 mm, frequent to abundant along the margins but scarce or absent at the apices of young lobes. MEDULLA white, rarely with spots of an orange pigment in the older parts. SOREDIA, PUSTULAE and ISIDIA absent. LOWER SURFACE black, shiny, smooth to rugose, weakly papillate or veined; MARGINAL ZONE shiny, brown, smooth to subrugose, 1.5–5.5(–9.0) mm wide, naked, turning cream, white, or variegated under lobes with apothecia; RHIZINES black, simple, sometimes furcate or irregular, 0.10–1.60(–2.30) \times 0.05(–0.15) mm, few to frequent but more abundant in some parts, occasionally becoming agglutinated, grouped. APOTHECIA submarginal or subterminal, originating in part from subcanaliculate lobes apices, common, \pm concave to urceolate, becoming fissured and distorted with age, up to 9.5 mm wide, stipes inflated, margins smooth when young, then subcrenate and short dentate-lacinulate, eciliate, amphithecia and stipe smooth when young, becoming rugose, veined or vertically folded with age, sometimes with papillose wrinkles; discs brown, epruinose, imperforate; ASCOSPORES ellipsoid, (19.0–)25.0–36.0(–40.0) \times (12.0–)14.0–18.0(–24.0) μ m, epispore 2.5–4.0(–5.0) μ m thick; PYCNIDIA submarginal, frequent to abundant, with black ostioles; CONIDIA unciform, (3.0–)4.0–5.0(–6.0) \times ca. 1.0 μ m.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C–, KC+ rose, P–, UV+ bluish green, with a K+ dark reddish pigment frequent only in old or necrotic areas of some thalli.

TLC/HPLC: cortical atranorin (minor) and chloroatranorin (minor); medullary alectoronic acid (major), α -collatolic acid (major), β -alectoronic acid (trace),

β -collatolic acid (trace), methyl pseudoalectoronate (trace) and methyl pseudo- α -collatolate (trace).

PARATYPES: Brazil, São Paulo State, Municipality of Cananéia, Cardoso Island, restinga wood of Marujá Village, post-dune restinga vegetation at the southern part of the island, wood of bushes and small trees, 25°14'S, 48°01'W, 5 m alt., on small tree thin branch, leg. M.P. Marcelli 1747, 1751, 1752, 1753, 1754, 1755, 1756, 1761, 1762, 1763, 1764, 1766, 1767, 1768, 1769, 1770, 1771, 1772, 1775 (SP), 1759 (B) 20-X-1981. Municipality of Iguape, Barra do Ribeira, between Suamirim "River" and the ocean, low restinga forest near the mangrove, 24°38'S, 47°22'W, 2 m alt., on small tree trunk, leg. M.P. Marcelli & O. Yano 6375, 15-VII-1989 (G); idem, on thin small tree branch, leg. M.P. Marcelli & O. Yano 6872, 6873, 18-VII-1989 (SP); idem, sand dunes vegetation, 24°38'S, 47°22'W, 5 m alt., thin branch of small tree, leg. M.P. Marcelli & O. Yano 6808, 10-VII-1989 (SP); idem, urban zone, 24°39'S, 47°22'W, 5 m alt., tree trunk at the sidewalk, leg. M.P. Marcelli & O. Yano 7112, 7117, 7134, 22-VII-1989 (SP). Municipality of Ilha Comprida, Gambôa Nóbrega, 25°01'S, 47°54'W, 1 m alt., small tree trunk, leg. M.P. Marcelli 1594, 16-II-1982 (SP); idem, central area of the island, low restinga forest behind the propriety of the Kitaura family, 24°51'S, 44°42'W, 2 m alt., thin branch of small tree, leg. M.N. Benatti, A.A. Spielmann, L.S. Canêz, M.J. Kitaura & M.P. Marcelli 1730, 1748, 1749 (SP), 1747 (ASU), 02-IV-2004. Municipality of Peruíbe, margin of Guaraú River, mangrove at the edge of the river, 24°23'S, 47°02'W, 5 m alt., on trunk of *Rhizophora mangle*, leg. M.P. Marcelli & O. Yano 3907, 3909, 3927, 23-VII-1988 (SP).

COMMENTS: *Parmotrema restingense* is characterized by the absence of vegetative propagules, the densely ciliate margins that are sparsely and irregularly sublacinulate, the apothecia with smooth or shortly denticulate, always eciliate margins, and a lower cortex which is brown at the margins becoming white or cream only under the apothecia.

This is the most common species of the alecronic acid containing group along the coast of São Paulo State. Previously it may well have been mistaken for *P. subrugatum*, which has a shiny white margin and only becomes pale brown in a very narrow transition zone towards the black center. In *P. restingense* the marginal zone is always brown, becoming white to ivory colored only under lobes bearing apothecia.

The frequent, ramified, subcanaliculate lacinules of *P. subrugatum* are very different from the uneven, short and simple, dentate lacinules seen in *P. restingense*. While the lacinules in *P. restingense* rarely exceed 1.5 mm in length (usually resulting from the irregular incised margins), those in *P. subrugatum* are regular in shape and branching pattern and may exceed 1 cm in length.

Similarly, the apothecia of *P. restingense* invariably have a smooth, eciliate margin that only becomes dentate with age, while those of *P. subrugatum* sometimes have apical cilia and frequent small lacinules (see below). The epithet refers to the predilection of the species for restinga forest habitats at the southeastern Brazilian littoral.

Parmotrema subrugatum (Kremp.) Hale, Phytologia 28: 339. 1974.

FIG. 3

MYCOBANK MB 343135

= *Parmelia subrugata* Kremp., Verh. Zool. Bot. Gesell. Wien 18: 320. 1868.

HOLOTYPE: Brazil, Rio de Janeiro State, Serra dos Órgãos (Organ Mountains), leg. Helmreichen s.n. (M!).

THALLUS up to 11.0 cm wide, subcoriaceous, corticolous, becoming dark greenish gray in the herbarium, lobate to sublobate. LOBES 2.5–7.0 mm wide, irregularly branched, crowded, not adnate, subascending and distorted, loosely attached; APICES plane to subconvex and revolute when lacinulate, subrotund to subirregular; MARGIN smooth near the apices, soon turning subirregular, ± flat to ascending and becoming subundulate, involute or revolute, normally giving the lobes a canaliculate aspect, entire to irregularly incised, commonly lacinulate, ciliate. UPPER SURFACE continuous but becoming irregularly cracked with age, subrugose to rugose; MACULAE usually distinct, punctiform and aggregated, appearing irregularly on the lamina or frequently forming on the amphithecia and stipes of the apothecia where they sometimes become linear. ADVENTITIOUS LACINULES very common, short to medium, regularly distributed along the apices and margins of the lobes, occasionally intermixed with some small irregular lobules, often agglomerated, simple at first but soon becoming irregularly dichotomously branched, flat to partially subcanaliculate, 1.2–8.3 × 0.3–1.2 mm, normally truncate, often ciliate, underside generally cream and concolorous with the lower margin. CILIA black, simple to sometimes furcate or irregularly ramified, 0.3–2.5 × ca. 0.05 mm, usually common along the margins but scarce or absent at the apices of young lobes. MEDULLA white, spots of orange pigments absent even in the older parts. SOREDIA, PUSTULAE and ISIDIA absent, but with some grouped papilloid, dactyliform, massive and ± ciliate structures resembling thick isidia without a constricted base, 0.4–1.5 × 0.2–0.5 mm, ramified, appearing on some parts of the cortex or sometimes on the stipes of the apothecia, sometimes difficult to distinguish from the young apothecia, partially developing into laminal lacinules similar to those on the margins. LOWER SURFACE black, shiny, smooth to subrugose, weakly papillate; MARGINAL ZONE naked, shiny to opaque, smooth to subrugose, 1.0–6.5 mm wide, normally cream or white in an almost continuous line in the distal portions; brown only in young, smaller lobes bearing no lacinules or apothecia; CENTER black; RHIZINES black, simple, rarely furcate or irregular, 0.20–1.40(–2.20) × 0.05(–0.15) mm, frequent to abundant at some parts, often becoming agglutinated. APOTHECIA submarginal or subterminal partially originating from the subcanaliculate lobes apices, common, ± concave to urceolate, normally fissuring and becoming distorted with age, up to 17.5 mm diam., stipes inflated, margins smooth when young, then denticulate and sometimes lacinulate, eciliate except at the apices of the lacinules, amphithecia

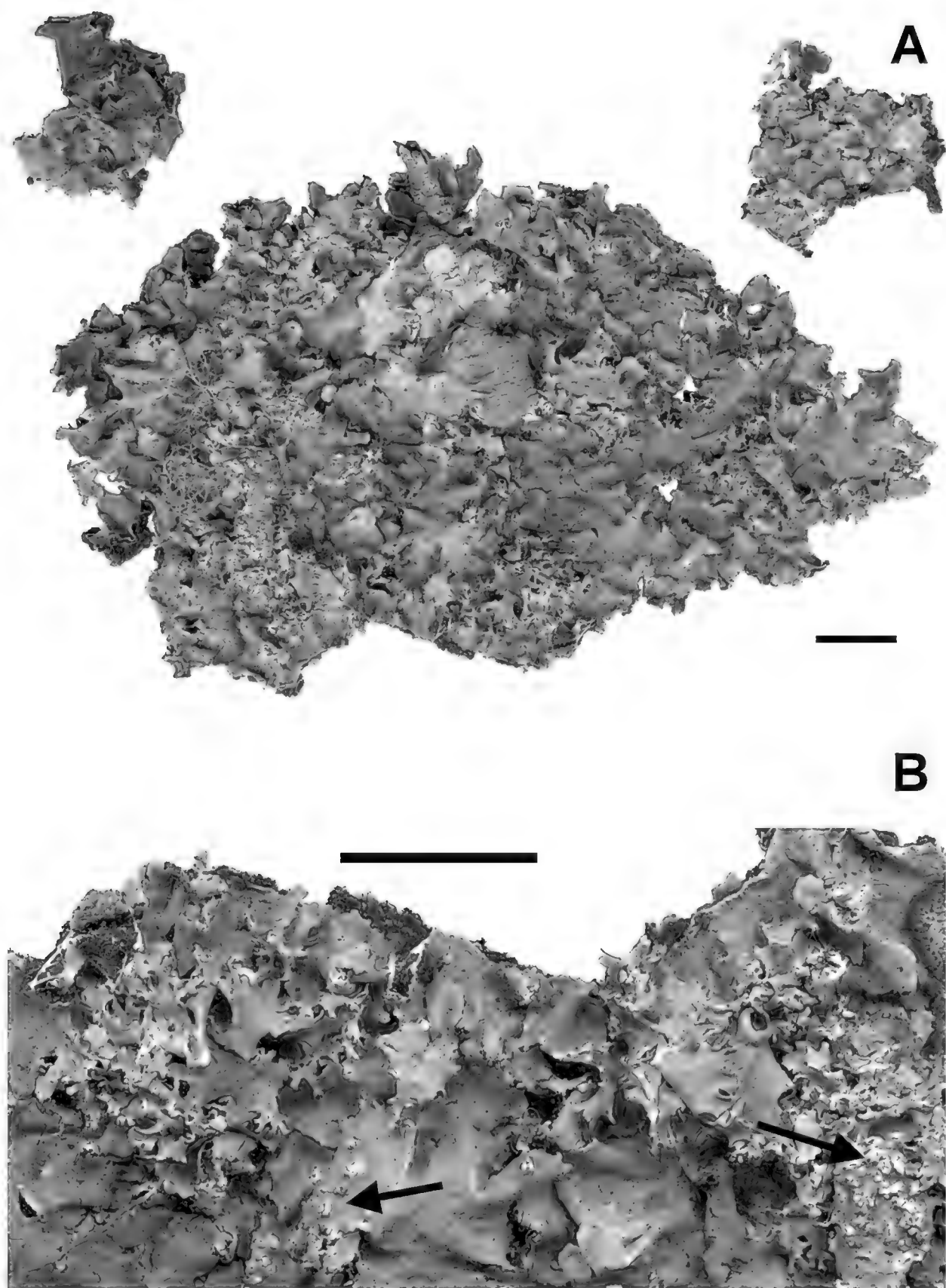


FIGURE 3. The holotype of *P. subrugatum*. A. The entire specimen.
B. Details of the marginal lacinules and the papilloid structures (arrows) that give rise to them.
Bars = 1 cm.

and stipe smooth when young, becoming strongly rugose and veined with age, sometimes with a few papilloid-isidioid structures as seen on the upper surface; disc dark brown, epruinose, imperforate or partially perforate when mature; ASCOSPORES ellipsoid to ovoid, $(17.5\text{--})26.5\text{--}35.0 \times (12.0\text{--})15.0\text{--}22.0 \mu\text{m}$, episore $2.5\text{--}4.0 \mu\text{m}$ thick; PYCNIDIA mainly submarginal and on the lacinules, frequent to abundant, with black ostioles; CONIDIA unciform, $(4.0\text{--}5.0\text{--}6.0 \times \text{ca. } 0.75 \mu\text{m})$.

COLOR REACTIONS: upper cortex K+ yellow, UV–; medulla K–, C–, KC+ rose, P–, UV+ bluish green.

TLC: cortical atranorin; medullary alectoronic acid and α -collatolic acid, with or without rhodophyscin (fide Culberson 1969).

COMMENTS: *Parmotrema subrugatum* is characterized by the absence of vegetative propagules, the ciliate margins regularly developing dichotomously branched lacinules, the presence of laminal digitiform structures, the denticulate to lacinulate apothecia which are only ciliate at the apices of the lacinules, and by the black lower cortex with an usual white or cream marginal zone that is almost continuous along the distal parts of the thallus.

The name *P. subrugatum* has apparently been misapplied to several different species, some of which appear as synonyms in Hale's classic monograph on *Parmelia* subgen. *Amphigymnia* (Hale 1965). This species is apparently one of the most frequently confused species of those containing alectoronic acid, and its name has been misapplied for specimens which have a white (at least in part) lower marginal zone, eciliate apothecia, large ellipsoid ascospores ($25\text{--}40 \mu\text{m}$ long) and short conidia ($4\text{--}6 \mu\text{m}$ long).

Hale (1965) described *P. subrugatum* as having broad lobes ($7\text{--}15 \text{ mm}$ wide) with an ivory to brown or mottled lower margin. However, when comparing *P. maraense* Hale to *P. subrugatum* (Hale 1990), he refined his species concept, mentioning that *P. subrugatum* has a continuous white margin that turns dirty white with age.

The holotype of *P. subrugatum* (M!, FIGURE 3A) has an almost uniformly white marginal zone which distinguishes it from the other species of this group, where the marginal zone is initially brown and becomes pale only on aging. In this specimen, the margin is almost entirely shiny cream (probably white when freshly collected), with a few young lobes having a brown color.

This species normally forms abundant small, dichotomously branched lacinules along the margins throughout the thallus. In addition, they sometimes develop from the upper cortex, growing from scattered, isidioid-papillate structures (FIGURE 3B). These structures are quite different from anything we have seen in other species of the alectoronic chemical complex, and although

they resemble large, thick isidia without a constricted base, their function is not apparent. In some parts, they resemble poorly developed apothecial primordia, and can readily be confused with them. However, on further development, their shape diverges from that of primordial apothecia and eventually they may form dichotomously branched lacinules like those along the margins.

Poorly developed thalli of *P. subrugatum* and *P. restingense* may appear very similar. One should look for true lacinules along the margins and the overall color of the lower marginal zone for confirmation. The presence of the papillate structures on the upper surface is also important for distinguishing *P. subrugatum*.

Parmotrema subrugatum is a species described from southeast Brazil, from a place mostly covered by the Atlantic rainforest, perhaps little above 1000 m high (Serra dos Órgãos) where commonly the trees become shorter and the cloud forest begins to appear. The additional specimen studied came from a place with similar climate and vegetation but of higher latitude.

ADDITIONAL SPECIMEN EXAMINED: Brazil, Rio Grande do Sul State, Municipality of Sobradinho, open place near the road, 29°24'20.2"S, 53°01'25.9"W, 375 m alt., corticolous, leg. A.A. Spielmann 360, 17-VII-2003 (SP).

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Literature cited

- Benatti MN. 2005. Os gêneros *Canomaculina*, *Parmotrema* e *Rimelia* (*Parmeliaceae*, *Ascomycetes*) no litoral centro-sul do Estado de São Paulo. MSc dissertation. Instituto de Botânica, São Paulo. 389 pp.
- Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press, New Haven and London. 795 pp.
- Bungartz F. 2001. Analysis of lichen substances. In http://nhc.asu.edu/lichens/lichen_info/tlc.jsp#TLC2. Accessed on July 2008.
- Culberson CF. 1969. Chemical and Botanical Guide to Lichen Products. University of North Carolina Press, Chapel Hill. 628 pp.
- Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. *Bibliotheca Lichenologica* 86: 1–7.
- Hale ME. 1965. A monograph of the *Parmelia* subgenus *Amphigymnia*. *Contributions from the United States National Herbarium* 36(5): 193–358.
- Hale ME. 1990. New species of *Parmotrema* (*Ascomycotina: Parmeliaceae*) from tropical America. *Bibliotheca Lichenologica* 38: 109–119.

- Krog H. 1991. Lichenological observations in low montane rainforests of eastern Tanzania. Pp. 85–94, in Galloway DJ (Ed.), *Tropical Lichens: Their Systematics, Conservation, and Ecology*. The Systematics Association Special Volume, Clarendon Press, Oxford.
- Nash TH III, Elix JA. 2002. *Parmotrema*. Pp. 318–329, in Nash III TH, Ryan BD, Diederich P, Gries C, Bungartz F (Eds.), *Lichen Flora of the Greater Sonoran Desert Region*. Volume 1. Lichens Unlimited, Arizona State University, Tempe.

Three lichenized fungi new to Turkey

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Abstract — In this study, three lichenized fungi (*Gyalecta ulmi*, *Ochrolechia subviridis* and *Opegrapha viridis*) are reported for the first time from the Turkish provinces of Çanakkale, İstanbul and Kırklareli. Comments on their habitat and substrata and a short description are provided for each taxon.

Key words — Ascomycota, epiphytic lichens, *Quercus* sp., *Fagus* sp.

Introduction

The total number of papers referring to lichens from Turkey was 361 at the end of 2004 (John 2004). Thereafter many studies have been carried out about the lichens of Turkey (Tufan et al. 2005, Güvenç et al. 2006, John & Türk 2006, Halıcı et al. 2007, Kınalıoğlu 2007, Candan & Türk 2008, Çobanoğlu et al. 2008, Halıcı & Aksoy 2009). In spite of the increase in the number of studies, knowledge of the lichen flora in Turkey is still insufficient. This paper aims at contributing to the knowledge of the lichen flora of Turkey.

Materials and methods

The specimens are stored in BULU (Herbarium of Uludag University, Science and Art Faculty, Bursa, Turkey) and their accession numbers are given in parenthesis at the end of the locality information. The specimens were examined with an Olympus SZ40 model stereomicroscope, and a Kruss light microscope. Specimens were examined in water, 10% KOH, and Lugol's iodine solution. Spore measurements were generally carried out in water.

Species recorded

Gyalecta ulmi (Sw.) Zahlbr. 1905

Detailed descriptions are provided by Clauzade & Roux (1985: 374), Purvis et al. (1992: 262) and Wirth (1995: 412).

Thallus thin or thick, smooth or cracked, whitish. Apothecia 0.5–2mm diam, numerous; true exciple pale, white-pruinose, smooth or often crenate; disc

concave orange-brown to chestnut-brown and pruinose. Ascospores $15\text{--}25 \times 5\text{--}9 \mu\text{m}$, 3-septate, broad ellipsoid.

SPECIMEN EXAMINED—ÇANAKKALE: Bayramiç; Kaz Dağı, Yeşilköy, Kırgındere place, oak woodland, $39^{\circ}51'56''\text{N}$, $26^{\circ}50'46''\text{E}$, alt. 643 m, on bark of *Quercus frainetto*, 18 Aug. 2005, leg. S. Oran, det. S. Oran (BULU 13843).

Gyalecta ulmi generally grows on calcareous substrata, such as soil and mosses in limestone areas, and is found on mature trees (e.g. *Ulmus*) in humid and sheltered sites (Purvis et al. 1992). Zedda (2002) reported this species from the trunks of old *Quercus pubescens* from Sardinia (Italy) and we recorded it from the trunks of *Q. frainetto*.

This is a rather rare lichen, found from Scandinavia to the Mediterranean-montane zone and known only from Europe and North Africa. Its populations are declining in many parts of Europe and it is a good indicator of long forest ecological continuity (Purvis et al. 1992, Wirth 1995, Zedda 2002).

Ochrolechia subviridis (Høeg) Erichsen 1930

Detailed descriptions are provided by Clauzade & Roux (1985: 530), Purvis et al. (1992: 400), Wirth (1995: 617), and Fos (1998: 210).

Thallus thick, smooth or warted, often densely covered with soft, branched or firm coralloid, cylindrical isidia, to 0.5 mm diam, becoming confluent towards centre and forming a continuous, uniformly concolorous crust, often breaking down into granular soralia. Apothecia rare. Isidia KC (+) red, C (+) red.

SPECIMENS EXAMINED—ÇANAKKALE: Çan; road of Bayramiç–Çan, in the vicinity of Hacıkasım village, oak woodland, $39^{\circ}56'46''\text{N}$, $26^{\circ}48'53''\text{E}$, alt. 297 m, on bark of *Quercus frainetto*, 06 Jul. 2005, leg. S. Oran, det. S. Oran (BULU 13595).

İSTANBUL: Sarıyer; Belgrad Forests, Topkoru place, oak forest, $41^{\circ}11'05''\text{N}$, $28^{\circ}59'07''\text{E}$, alt. 138 m, on bark of *Quercus petraea*, 12 Jun. 2006, leg. S. Oran, det. S. Oran (BULU 14619).

KIRKLARELİ: Demirköy; Demirköy–Sivriler road, 7. km, $41^{\circ}48'19''\text{N}$, $27^{\circ}49'01''\text{E}$, alt. 195 m, on bark of *Quercus petraea*, 24 Jul. 2006, leg. S. Oran, det. S. Oran (BULU 11658).

This widespread species is found on bark of woodland and wayside broad-leaved trees (like *Quercus*) in submontane localities, humid and non-eutrophicated areas (Purvis et al. 1992, Wirth 1995).

Ochrolechia subviridis is frequent and occurs in oceanic and suboceanic Europe, British Isles, North America, Japan, and Korea (Purvis et al. 1992). In Europe it is known from southern Scandinavia to the Mediterranean region (Zedda 2002, Wirth 1995) and Syria (John et al. 2004).

Opegrapha viridis Pers. 1803

Detailed descriptions are provided by Clauzade & Roux (1985: 540), Purvis et al. (1992: 414) and Wirth (1995: 628).

Thallus very thin or inconspicuous, usually in small (2–4 cm) patches, dull olive or brown. Apothecia $0.4\text{--}1 \times 0.12\text{--}0.4$ mm, sessile, initially semi-immersed, short, rounded, scattered, seldom shortly furcate, often elliptical or button-like. Exciple K (+) olive-green; hymenium I (+) red. Ascospores $23\text{--}60 \times 6\text{--}9$ μm , 8 to 15-septate, with a perispore.

SPECIMENS EXAMINED—KIRKLARELİ: Demirköy; road of Sarpdere–Balaban, oak and beech forest, $41^{\circ}52'19''\text{N}$, $27^{\circ}36'17''\text{E}$, alt. 351 m, on bark of *Fagus orientalis*, 15 Jun. 2006, leg. S. Oran, det. S. Oran (BULU 15001). Kofçaz; road of Kula–Kocayazı, 9 km before Kocayazı, oak and beech forest, $41^{\circ}59'42''\text{N}$, $27^{\circ}16'30''\text{E}$, alt. 492 m, on bark of *Fagus orientalis*, 16 Jun. 2006, leg. S. Oran, det. S. Oran (BULU 15115). Demirköy; Demirköy–Sivriler road, 7. km, $41^{\circ}48'19''\text{N}$, $27^{\circ}49'01''\text{E}$, alt. 195 m, on bark of *Quercus cerris*, 24 Jul. 2006, leg. S. Oran, det. S. Oran (BULU 15326).

Opegrapha viridis grows on smooth, young (rarely old) shaded bark, particularly on broad-leaved trees (e.g., *Acer*, *Corylus*, *Ilex*, *Quercus*, *Salix*) in old woodland (Purvis et al. 1992).

This species occurs throughout the Euro-Siberian region and is widespread in Europe from southern Scandinavia to the Mediterranean region; it is also known from Asia (Wirth 1995, Zedda 2002). It is very local and recorded from England, Scotland, Ireland, Sweden, France, Germany, North America, and Tasmania (Purvis et al. 1992).

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Literature cited

- Candan M, Özdemir Türk A. 2008. Lichens of Malatya, Elazığ and Adıyaman provinces (Turkey). *Mycotaxon* 105: 19–22.
- Clauzade G, Roux C. 1985. Likenoj De Okcidenta Eŭropo. Ilustrita Determinlibro. Royan. Bulletin de la Société Botanique du Centre-Ouest Nouvelle série–Numéro Spécial.
- Çobanoğlu G, Sevgi E, Sevgi O. 2008. Epiphytic lichen mycota of, and new records from, Şerif Yüksel Research Forest, Bolu, Turkey. *Mycologia Balcanica* 5: 135–140.
- Fos S. 1998. Líquenes Epífitos de los Alcornocales Ibéricos. Correlaciones Bioclimáticas, Anatômicas Y Densimétricas Con el Corcho de Reprodución. *Guineana* 4: 1–507.
- Güvenç Ş, Öztürk Ş, Aydın S. 2006. Contributions to the lichen flora of Kastamonu and Sinop provinces in Turkey. *Nova Hedwigia* 83: 67–98.
- Halıcı MG, Candan M, Özdemir Türk A. 2007. New records of lichenicolous and lichenized fungi from Turkey. *Mycotaxon* 100: 255–260.
- Halıcı MG, Aksoy A. 2009. Lichenized and lichenicolous fungi of Aladağlar National Park (Niğde, Kayseri and Adana Provinces) in Turkey. *Turk J of Botany* 33: 169–189.

- John V. 2004. Lichenological studies in Turkey and their relevance to environmental interpretation. Abstract book, XI OPTIMA meeting, 5.–11.9.2004 Belgrad: 45.
- John V, Seaward MRD, Sipman HJM, Zedda L. 2004. Lichens and lichenicolous fungi from Syria, including a first checklist. *Herzogia* 17: 157–177.
- John V, Türk A. 2006. Species/area curves for lichens on gypsum in Turkey. *Mycologia Balcanica* 3: 55–60.
- Kınalıoğlu K. 2007. Lichens of the alpine region in Araklı-Sürmene district, Trabzon province (Turkey). *Cryptogamie, Mycologie* 28(2): 159–168.
- Purvis OW, Coppins BJ, Hawksworth EL, James PW, Moore DM. (Eds.) 1992. The lichen flora of Great Britain and Ireland. London, Natural History Museum Publications.
- Tufan Ö, Sümbül H, Özdemir Türk A. 2005. The lichen flora of the Termessos National Park in Southwestern Turkey. *Mycotaxon* 94: 43–47.
- Wirth V. 1995. Die Flechten Baden-Württembergs, Teil 1–2. Stuttgart, Ulmer.
- Zedda L. 2002. The epiphytic lichens on *Quercus* in Sardinia (Italy) and their value as ecological indicators. *Englera* 24:1–457.

Lepiotaceous fungi in California, U.S.A. *Leucoagaricus* sect. *Piloselli*

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Abstract — Eighteen red-bruising taxa in the *Leucoagaricus/Leucocoprinus* clade (*Agaricaceae*) are listed for California. Thirteen taxa are described in detail, with 7 proposed as new and 2 single specimen collections remaining unnamed. The species, all of which turn green with ammonia and produce spores without a germ pore, fall into 2 morphological groups (not phylogenetically supported): the pileus of one group comprises a trichodermal covering and the pileus surface of the second bears strands of repent, coloured hyphae. New taxa in the latter group are *La. flammeotinctoides* (more robust than *Lepiota flammeotincta* and with clavate cheilocystidia), *La. pyrrhophaeus* with irregular cheilocystidia and copper colours in the dried basidiocarps, and *La. pyrrhulus* with amygdaliform spores. Taxa in the ‘trichodermal’ group — *L. fuliginescens*, *La. cupresseus*, and *La. erythrophaeus* as well as new species *La. adelphicus*, *La. pardalotus*, *La. hesperius*, and *La. dyscritus* — are differentiated based on pileus covering, cheilocystidia, and reactions of the lamellae when damaged. The type collections of *L. fuliginescens* and *L. flammeotincta* were studied. DNA sequence data for all species are given and a key to 19 taxa, including *La. georginae* (from Washington), is provided.

Key words — biodiversity, *Leucoagaricus badhamii*, *La. pilatianus*, nrITS, type studies

Introduction

Classification

Leucoagaricus section *Piloselli* Singer harbours those species within the *Leucoagaricus/Leucocoprinus* clade of the *Agaricaceae* that stain red when bruised and discolour green with ammonia. The concept of this section has been changing over time, and which species belong to it has been subject to debate. Singer (1973) described the section, based on Kühner’s work (1936), for species with lamellae that turn pink, have a white or lilac pileus, and a surface that reacts green with ammonia; *Lepiota georginae* (W.G. Sm.) Sacc. was chosen as the type. Locquin (1945) erected *Leucocoprinus* sect. *Anomali* Locq. (as “*Anomalae*”) for species that change colour, with *Lc. meleagris* (Sowerby) Locq. and *Lc. brunnescens* (Peck) Locq. as representatives. Heinemann (1973 – the

same year as Singer (1973) described section *Piloselli*) placed the reddening species in *Leucoagaricus* sect. *Anomali* Locq. One complication is that Locquin (1945) and Kühner (1936) did not give Latin descriptons to their infrageneric units, and so the combination of *Leucoagaricus* sect. *Anomali* has never been published validly. Furthermore, Locquin (1945) applied the name *Anomalae* also to a section in *Lepiota* characterized by the absence of clamp connections, and this section has been used in different ways by various authors (e.g. to accommodate species without clamp-connections within *Lepiota*, (Pegler 1986) though they belong to the *Leucoagaricus/Leucocoprinus* clade). A third section where species with a colour change have been placed is *Leucoagaricus* sect. *Annulosi* (Fr.) Singer (Singer 1973), typified by *La. leucothites* (Vittad.) Wasser, a white species that does not change colour and whose spores have a germ pore. Bon (1993) put *La. americanus* (Peck) Vellinga (as *La. bresadolae* (Schulzer) Bon) in *Leucoagaricus* subsect. *Rubescentes* (Wasser) Bon at the same time as he placed *La. meleagris* (Sowerby) Singer, a close relative of *La. americanus*, in sect. *Piloselli*.

Species that turn red, but not green, with ammonia and KOH, such as *La. croceovelutinus* (Bon & Boiffard) Bon & Boiffard, were also accommodated in sect. *Piloselli* (e.g. Bon 1993, Candusso & Lanzoni 1990).

Various authors placed some of those species in *Leucocoprinus* Pat. and other taxa in *Lepiota* (Pers. : Fr.) Gray. For example, Pegler (1986), who held a narrow concept of *Leucoagaricus* Singer and placed many of its species in *Lepiota*, listed *Lc. zeylanicus* (Berk.) Boedijn and *L. holospilota* (Berk. & Broome) Sacc. Other authors, e.g. Reid (1990), accommodated all reddening species in *Leucocoprinus*. Reid (1990) avoided a formal more detailed classification by referring species that stain with ammonia fumes to the “*Leucocoprinus badhamii* complex”.

Another complication in understanding the species and their relationships is that the concepts of *La. badhamii* (Berk. & Broome) Singer and *La. americanus* (as *La. bresadolae* in Europe) were mixed up in the literature until Demoulin (1966) put things straight (see also Reid 1990).

Leucoagaricus sect. *Piloselli* has been subdivided into two subsections based on the respective absence [subsect. *Pilatianeae* Migl. & L. Perrone (Migliozzi & Perrone 1992)] or presence [subsect. *Pilosellini* (Singer) Bon, *Pilatianeae*] of an apical excrescence on the cheilocystidia.

All the above attempts at classifications have been based on European collections. All European taxa, except *L. roseolivida* Murrill (syn. *La. marriagei* D.A. Reid), have a trichodermal pileus covering, whereas species with a cutis or entangled cutis, such as *L. flammeotincta* Kauffm., described from North America had not been taken into consideration.

Phylogenetic analyses of nrLSU and nrITS regions (Vellinga 2004a, 2004b) have shown that the three groups — those that redden with ammonia, those

that turn green with ammonia with spores without a germ pore, and those that turn green and have spores with a germ pore — do not form a monophyletic group. Rather the first and third groups are monophyletic (Vellinga & Sundberg 2008; Vellinga 2004a), while the second one (green with ammonia, no germ pore) is polyphyletic. The nrITS data do not seem to support a simple division of *Leucoagaricus* sect. *Piloselli* into two subsections either, although there are clades comprising species with an apical excrescence on the cystidia (e.g. the clade to which *La. georginae* (W.G. Sm.) Candusso belongs), but the species with clavate or otherwise non-appendiculate cystidia do not form a monophyletic group. Pileus covering characteristics are, unfortunately, also not a good predictor for phylogenetic relationships.

The “*La. americanus* + *La. meleagris*” group takes an isolated position in the *Leucoagaricus*/*Leucocoprinus* clade (Vellinga 2004a).

The red bruising reaction in *Leucoagaricus meleagris* is caused by lepiotaquinone, an amino-1,4-benzoquinone derivative (Aulinger et al. 2000); N.B. the authors identified their specimens as *L. americana*, but the material turned out to be *La. meleagris* (pers. obs.). It is not known whether this same chemical causes the reddening reaction in all species.

Species recognition

It has proven impossible to classify every single collection found so far; species recognition based on morphology alone is often challenging.

Specimens in the field look often quite different from those brought home for description and study, as the basidiocarps of many species turn very dark from handling. Furthermore, old, weather-beaten specimens of different species can look very much alike, again because of the colour changes. Microscopical characters often cast the decisive vote in the identification process.

Although the tentative new species thus far represented by only one collection are not formally described, they are described as well as included in the identification key.

No new combinations are made in *Leucoagaricus* for species still accommodated in *Lepiota*, as the taxonomy of this clade is not yet stable (Vellinga 2004a).

Scope of the article

The present paper focuses on the California species of section *Piloselli*. Here, for this study, we take the same pragmatic approach as Reid (1990) by covering those species that turn red when scratched and that turn green with ammonia vapours.

Several conspicuous species, some quite common, have been described from California (*L. fuliginescens*, *La. cupresseus*, *La. marginatus*), but the group is not

well covered in popular field guides (e.g. Arora 1986) or on web sites (e.g. Wood & Stevens 1996–2009). Species described from California by Murrill (1912) and Burlingham (1945) are now recognized, and their names used again.

The well-known species *L. flammeotincta* turned out to represent a complex of five different species with different nrITS sequences, but with only subtle microscopical differences and an almost identical macroscopical appearance.

The two reddening species with a germ pore in the spores, *La. americanus* and *La. meleagris*, are not treated here, although both fruit occasionally in California; descriptions based on European collections can be found in Vellinga (2001).

Vellinga (2007a) recently presented the lilac and dark pink species *L. roseo-livida* and *L. decorata* Zeller with full descriptions and comparisons with the type collections, which are not repeated here.

A description of *Lepiota castanescens* Murrill, a species that stains red with ammonia, has also recently been published (Vellinga & Sundberg 2008). *Leucoagaricus erythrophaeus* was recently described for the interpretation of *L. roseifolia*, but its description is given here as well, as it can easily be confused with some of the other species.

The key below covers all known Californian species in the *Leucoagaricus/Leucocoprinus* clade that change red on bruising, although some species concepts are not yet completely settled.

***Leucoagaricus* sect. *Piloselli* in North America**

Only a few reddening species have been described for the central, eastern, and southeastern parts of the U.S.A. *Leucoagaricus brunnescens* (Peck) Bon, described from Missouri (Peck 1904), is a small species that initially resembles *L. cristata* (Bolton : Fr.) P. Kumm. but changes colour on drying. Bon (1993) reported it for Europe, but whether it really is the same species is not clear.

Lepiota mutata Peck, a white species described from Kansas (Peck 1896) with a scurfy pileus surface that changes brown on drying might belong to section *Piloselli*.

Murrill described several species in the group of species with a germ pore: the widespread *La. americanus*, *L. muticolor* Murrill [from Alabama (Murrill 1914), for type study see Smith (1966)], and *L. sanguiflua* Murrill and *L. tinctoria* Murrill, both from Florida, and featured in an article on this group by Smith & Weber (1987). The last authors introduced an additional species in this group, *L. besseyi* H.V. Sm. & N.S. Weber, characterized by pleurocystidia. Of these species, only *La. americanus* has been encountered in California.

Diversity, ecology, and distribution

Further investigations and inventories of the state and its diverse habitats will undoubtedly add to the diversity, as we know it now. New species were being

discovered up to the very end of the research for this article, even in material collected from well-studied areas. Recognition of these new species is critical. As is the case with the small brown species in the *L. oculata* group (Vellinga 2007b), many different species co-inhabit the same habitat and locality.

Collecting trips focused on the coastal area from Monterey north to Humboldt County and on the San Francisco Bay area, with occasional surveys of the lower parts of the Sierra Nevada (Yuba and Nevada counties). Some ecological trends are now apparent. Species of the *L. flammeotincta* group, which have never been found under Monterey cypress (*Callitropsis macrocarpa* (Hartw.) D.P. Little (syn. *Cupressus macrocarpa* Hartw.; *Hesperocyparis macrocarpa* (Hartw.) Bartel), do grow under redwood (*Sequoia sempervirens* (D. Don) Endl.) and in forests of various conifer species with tanbark oak (*Notholithocarpus densiflorus* (Hook. & Arn.) Manos et al.) along the coast and inland. *Leucoagaricus cupresseus* is known from two kinds of habitats: Monterey cypress plantings in coastal settings and kitchen gardens. It does not occur in an old east-facing cypress plantation but can fruit abundantly on west facing slopes under cypresses used as wind breaks close to the coast. Only two species (*La. erythrophaeus* and *L. flammeotincta*) were encountered at lower elevations of the central Sierra Nevada, but this habitat is not well investigated for lepiotaceous fungi. Two species seem so far to be restricted to old Monterey cypress plantations (*La. dyscritus* and *La. hesperius*, both described in this paper); in general, this habitat is very rich in lepiotaceous species (Guinberteau et al. 1998, Vellinga 2004b). Distribution data for other west coast states are scarce, but it appears that California has a unique '*Lepiota*' flora, richer in species than the more northern regions. *Leucoagaricus georginae*, however, has been recorded from Washington, but has not been encountered in California, yet. Only *Lepiota fuliginescens*, *L. flammeotincta*, and *L. castanescens* are widespread in the Pacific Coast states. However, for most species distribution and ecological data are still very incomplete.

Material and methods

Standard methods for describing basidiocarps were applied, using the terminology of Vellinga & Noordeloos (2001). Colour annotations in the macroscopical descriptions are from Munsell™ soil color charts (1975). Microscopical observations were made on dried material. The notation [60,4,3] indicates that measurements were made on 60 spores in four samples in three collections. At least 15 spores were measured per collection. The lamellar characters and spore shape and size were observed in Congo Red in 10% ammonia followed by ammonia only, and the pileus covering was observed in 10% ammonia. The following abbreviations are used: L for number of lamellae, l for number of lamellulae in between two lamellae, avl for average length, avw for average width, Q for quotient of length and width, and avQ for average quotient. The abbreviation *L.* is used for *Lepiota*, *La.* for *Leucoagaricus* and *Lc.* for *Leucocoprinus*.

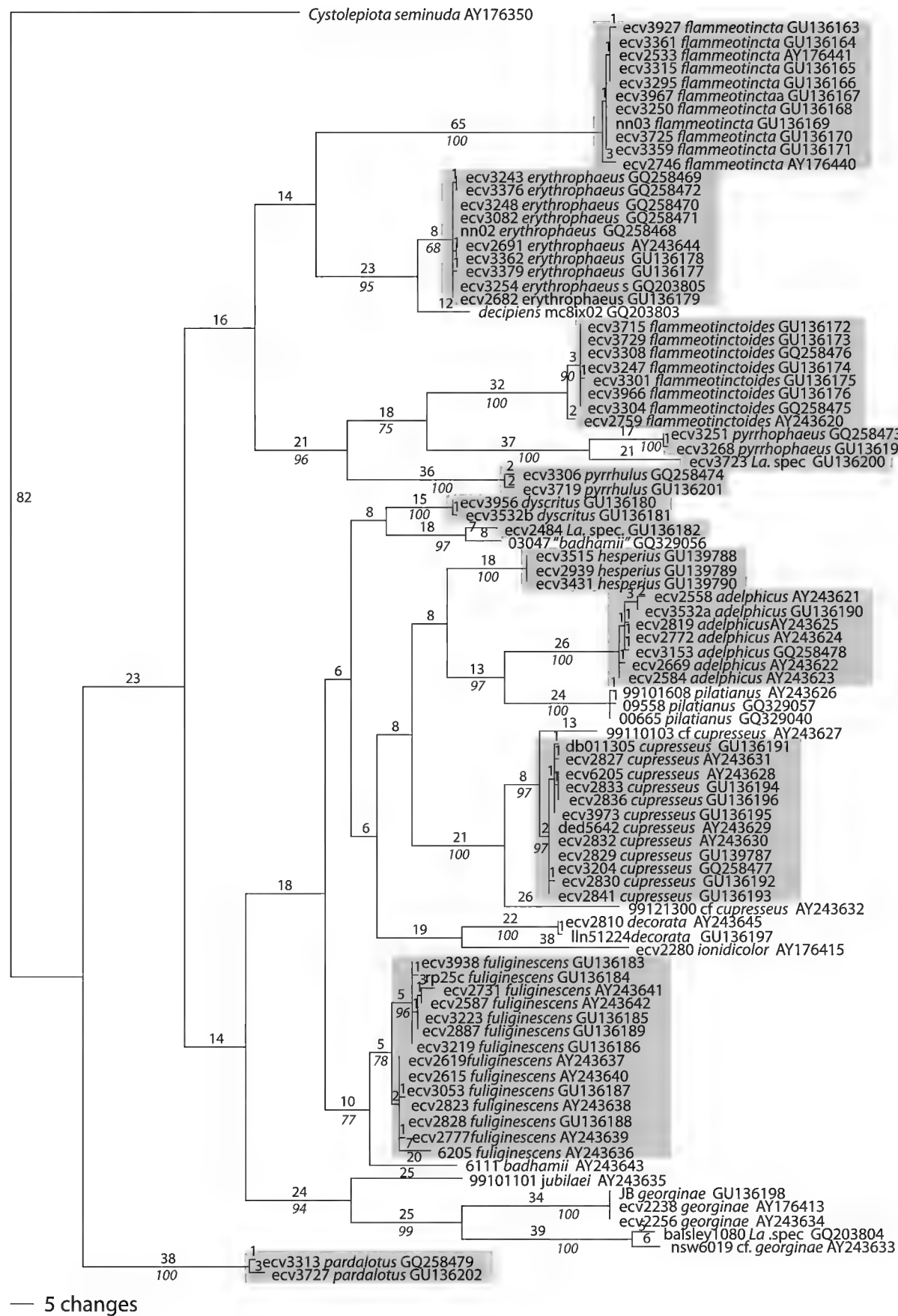


FIG. 1. Phylogram based on parsimony analyses of the nrITS region of species in *Leucoagaricus* sect. *Piloselli*. One of 10,000 MPT's is depicted, based on 305 parsimony informative characters. *Cystolepiota seminuda* was chosen as outgroup. The numbers above branches refer to the number of changes, the ones below the branches are bootstrap values (> 65%). The taxa treated in this paper are highlighted.

All collections are in UC unless otherwise stated. Herbarium abbreviations are according to Holmgren & Holmgren (1998). Latin descriptions of new species have been deposited in MycoBank. For many species, multiple illustrations are given to show the variability among collections belonging to the same species.

DNA was extracted from dried material using a Qiagen DNeasy® Blood and Tissue kit (Qiagen, Valencia, CA, USA). The nrITS region was amplified with the ITS-1F/ITS-4 primer set with an MJ PTC-100™ thermocycler (Applied Biosystems, Foster City, CA, USA) under conditions previously described (Gardes & Bruns 1993). PCR products were cleaned using 0.5 µl of ExoSAP IT (USB Corp, Cleveland, OH, USA) per reaction and cycled at 37°C for 45 min, followed by 80°C for 15 min. Sequencing was performed using Big Dye chemistry and an ABI PRISM 3100 Genetic Analyzer (both from Applied Biosystems, Foster City, CA, USA). Sequences were edited and contigs assembled using Sequencher 4.2.2 (Gene Codes Corporation, Ann Arbor, MI, USA). Newly produced sequences were deposited in GenBank, and their accession numbers listed with the collections.

The nrITS sequences were aligned with the program MAFFT version 6 (Katoh et al. 2002). For the phylogenetic analyses the Maximum Parsimony option in PAUP* v4 (Swofford 2002) was used. The sequence data base was also analyzed by maximum likelihood method (ML) using RAxML version 7.2.3 (Stamatakis et al. 2008); 100 rapid ML bootstraps were performed, and bootstrap values are included in the MP tree of FIG. 1. *Cystolepiota seminuda* (Lasch) Bon was chosen as outgroup. The analyses were only performed to determine whether the sequences matched sequences of previously sequenced species and collections, and were not used to infer a phylogeny of section *Piloselli*.

Taxonomy

1. *Lepiota fuliginescens* Murrill, Mycologia 4: 236. 1912.

FIGURES 2–5

TYPE STUDY — Smith (1966: 105–106).

MICROSCOPICAL CHARACTERS (FROM VELLINGA TYPE STUDY; FIGURE 2) — BASIDIOSPORES [15,1,1] in side-view $6.0\text{--}7.6 \times 3.9\text{--}4.9 \mu\text{m}$, $\text{avl} \times \text{avw} = 6.7 \times 4.4 \mu\text{m}$, $Q = 1.36\text{--}1.64$, $\text{av}Q = 1.52$, ellipsoid, some subamygdaliform, in frontal view ellipsoid-ovoid, rather thick-walled, without germ pore, uni-guttulate, congophilous, immediately red-brown in Melzer's reagent (dextrinoid), metachromatic in Cresyl Blue. BASIDIA not observed. Lamella edge sterile. CHEILOCYSTIDIA abundant, $27\text{--}70 \times 8\text{--}16 \mu\text{m}$, clavate, fusiform-lageniform to clavate with abrupt apical, cylindrical to moniliform appendage ($12\text{--}28 \times 4\text{--}6 \mu\text{m}$), with brown contents in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING a cutis of cylindrical elements, $3\text{--}7 \mu\text{m}$ wide, with green-brown pigment in ammonia, giving rise to tufts of upright elements, $55\text{--}220 \times 9\text{--}19 \mu\text{m}$, narrowly fusiform and tapering towards apex or cylindrical with rounded apex, exuding green-brown pigment in ammonia, and with dark granules (as seen in ammonia). CLAMP CONNECTIONS not observed.

DESCRIPTION OF MODERN MATERIAL (FIGS 3–5)—PILEUS 35–90 mm, convex when young, expanding to plano-convex without, or more rarely with, umbo,

pale brown or pale grey (e.g. 10 R 4/3–2.5 YR 4/2; 5 YR–7.5 YR 5/3–4) when young, velvety all over, later with closed covering at centre or umbo (e.g. 7.5 YR 5/3) only and around centre splitting up into grayish patches (7.5 YR 6/3–6/4) forming a concentric pattern close to centre and radial pattern in outer $\frac{1}{4}$ of radius, on whitish background, paler around centre than at umbo, and discolouring red at first, to dark purple brown to dark brown with age; margin exceeding lamellae. LAMELLAE, L = 70–90, l = 0 or 1(–3), very crowded, free and remote from stipe, subventricose to distinctly ventricose, up to 5–7

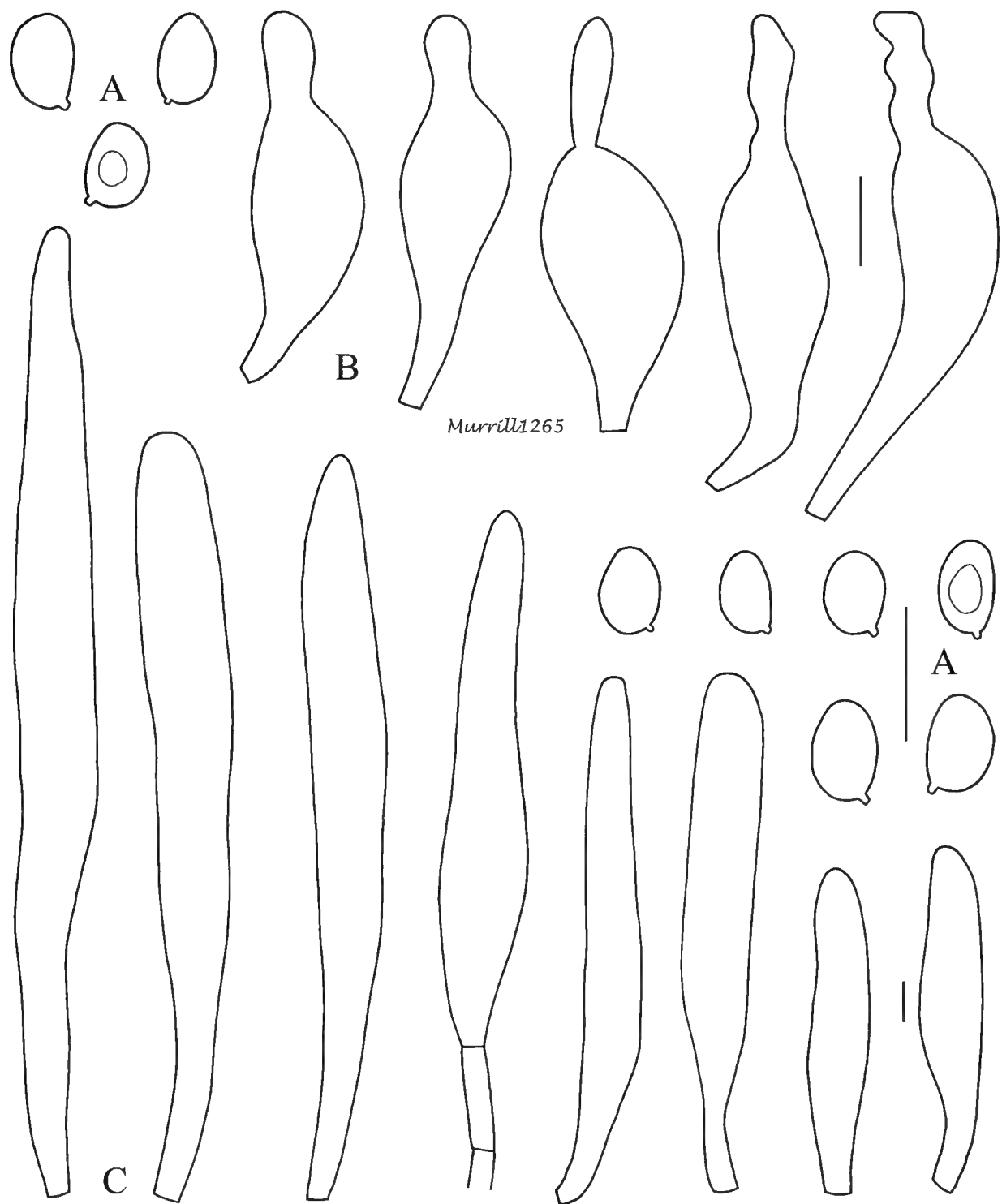


FIG. 2. *Lepiota fuliginescens* — A. spores; B. cheilocystidia; C. elements of pileus covering.(all from holotype collection). Scale bars 10 μ m.

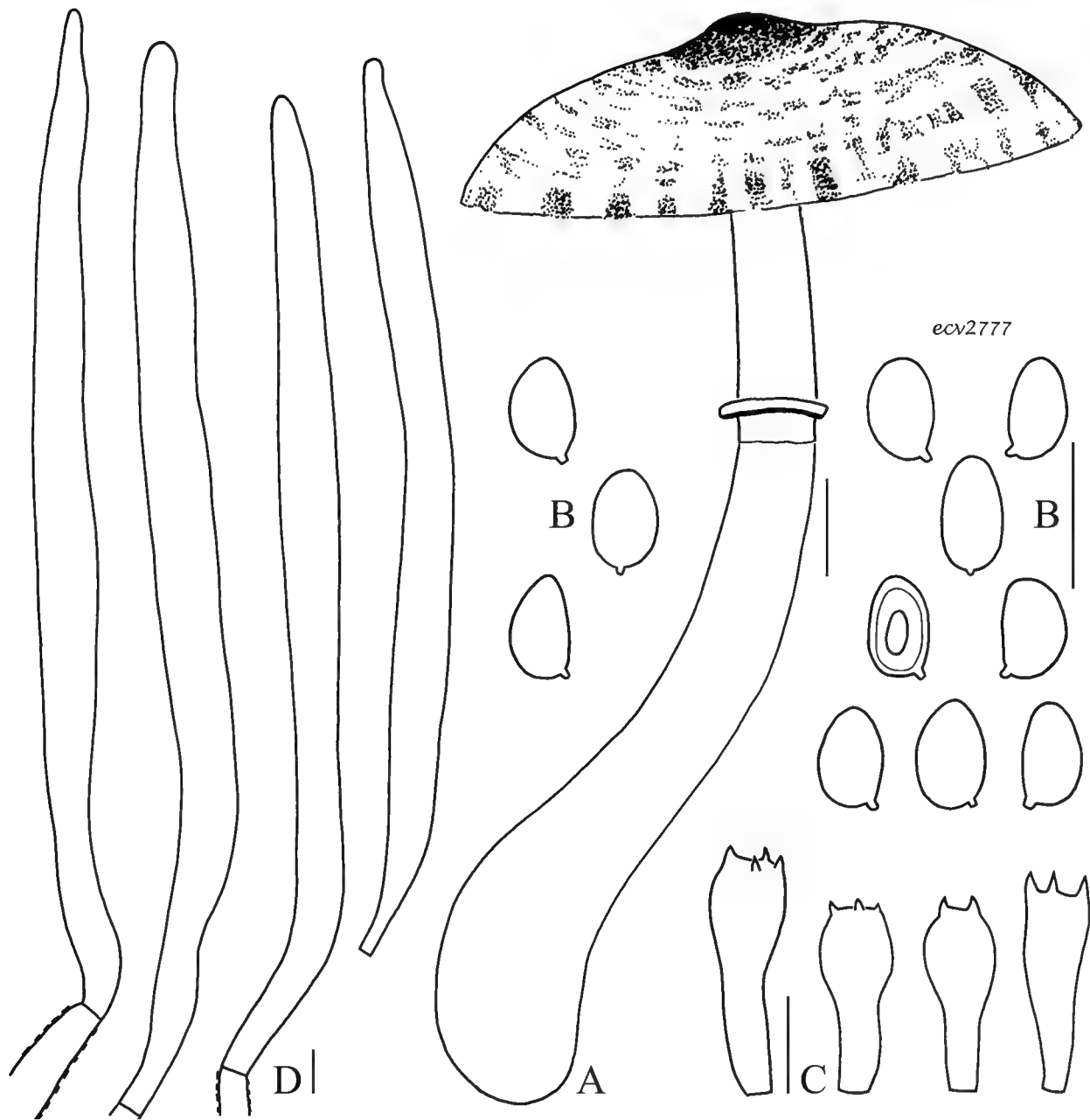


FIG. 3. *Lepiota fuliginescens* — A. Basidiocarp; B. spores, basidia, elements of pileus covering (all from ecv2777). Scale bar 10 mm (A); microscopic features 10 μ m.

mm wide, white when young, to whitish with pinkish sheen, discolouring immediately under pressure to orange-red, changing to almost black, with age often vinaceous-purplish pink coloured, with cystidiose edge starting white, but rapidly changing to dark especially near pileus margin and contrasting with rest of lamellae. STIPE 60–125 \times 5–16 mm, cylindrical but with up to 20 mm wide base, whitish all over when young, but rapidly changing when damaged to red, changing to dark brown with age, short fibrillose all over, but especially so above annulus, hollow, and white-tomentose at base. ANNULUS an ascending or descending cuff and a short, 2 mm wide, flaring part, sturdy, at first white and with rim concolourous with pileus centre, soon changing to dark brown, especially at edge. CONTEXT in pileus white at first, changing when cut via

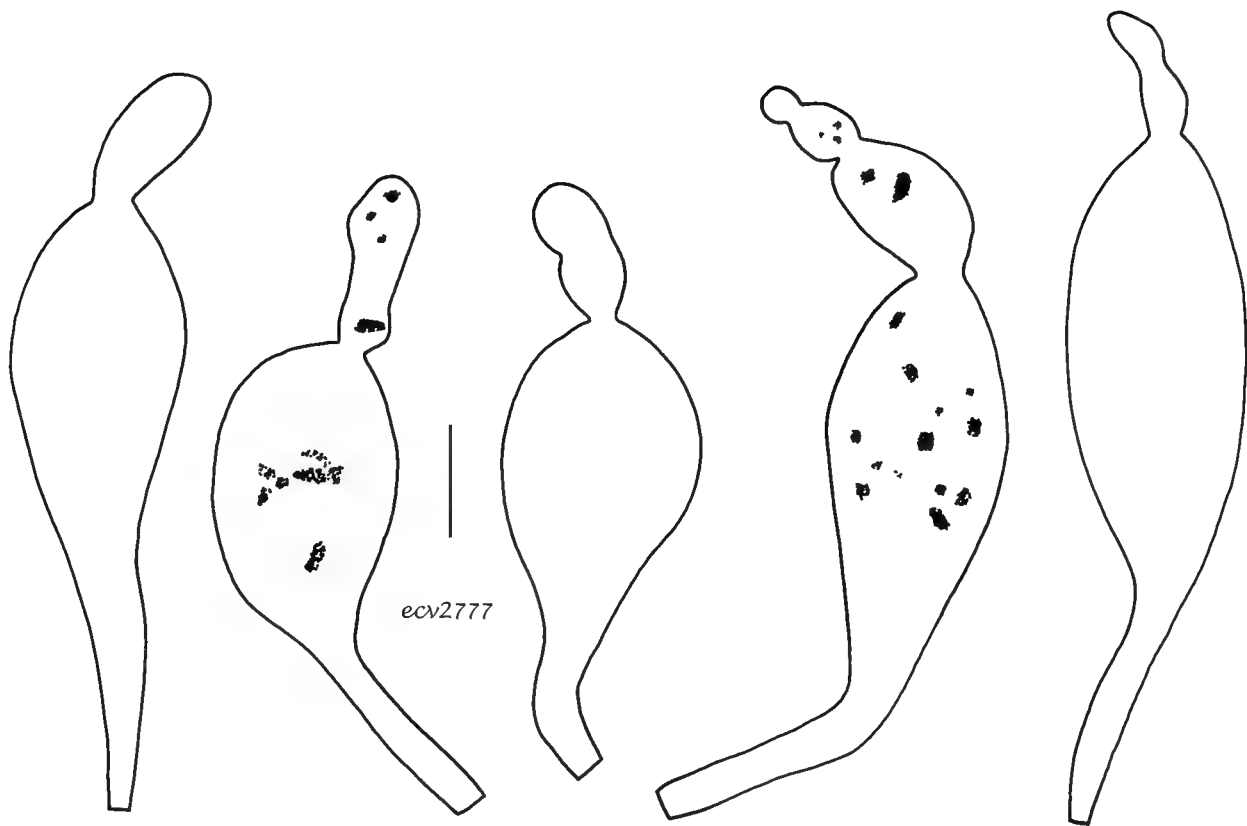


FIG. 4. *Lepiota fuliginescens* – Cheilocystidia (from collection ecv2777).
Scale bar 10 μm .

yellow to orange-red, or directly orange, in places; discoloration soon fading; in stipe white and shiny, or whitish and non-changing. SMELL like the rubber component of the smell of *Lepiota cristata*, indistinct, slightly rancid.

CHEMICAL TESTS — KOH 3% on lamella surface first red, changing to green.

DRIED SPECIMENS dark with dark lamellae.

BASIDIOSPORES [296,19,19] in side view $5.8\text{--}8.8 \times 3.5\text{--}5.2 \mu\text{m}$, $\text{avl} \times \text{avw} = 6.1\text{--}7.3 \times 3.8\text{--}4.5 \mu\text{m}$, $Q = 1.3\text{--}2.1$, $\text{av}Q = 1.6\text{--}1.85$, ellipsoid to oblong, often amygdaliform, in frontal view ovoid or ellipsoid to oblong, uniguttulate, congophilous, dextrinoid, metachromatic in Cresyl blue, without germ pore. BASIDIA $15\text{--}30 \times 6.0\text{--}9.0(-12) \mu\text{m}$, 4-spored, rarely intermixed with some 2-spored ones. LAMELLA EDGE sterile. CHEILOCYSTIDIA $19\text{--}60 \times 6.0\text{--}25 \mu\text{m}$, in most cases with apical, moniliform to cylindrical excrescence, $2.0\text{--}33 \times 2.0\text{--}9.0 \mu\text{m}$, with clavate to lageniform body, with dark granules and green-brown diffuse pigment in ammonia; in fresh material with green contents in ammonia. PLEUROCYSTIDA absent. PILEUS COVERING trichodermal, made up of upright long and relatively slender to more squat and relatively short elements, $58\text{--}330 \times 10\text{--}27 \mu\text{m}$, rarely with predominantly short elements not exceeding $100 \mu\text{m}$; elements with rounded apex, slightly thick-walled, with brown intracellular (often in blobs) and dark brown (at base of elements) to pale brown (at apex) parietal pigment; in fresh material with some elements with

blue-green contents in ammonia; repent hyphae on pileus surface cylindrical, with incrusting pigment especially in the cells just below the upright elements, and also with brown granular pigment (all pigment observations in ammonia). CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION – Solitary to gregarious in small groups, terrestrial on litter-rich soil, in various forest types, e.g. *Callitropsis macrocarpa* stands, under *Sequoia sempervirens* and other conifers in mixed woods, throughout coastal northern California, also in the Pacific Northwest, not uncommon. November to March in California, fruiting earlier in more northern regions.

COLLECTIONS EXAMINED – U.S.A., Washington, Skagit Co., Whidbey Island, Deception Pass State Park, 28-X-1995, S.A. Trudell 95-301-01. California, Alameda Co., Berkeley, UC-Berkeley campus, on the bank of Strawberry Creek, 6 December 2001, E.C. Vellinga 2777 (nrITS AY243639); ibidem, 7 January 2002, E.C. Vellinga 2823 (nrITS AY243638). Marin Co., Mount Tamalpais, Alpine-Kent Pump Road, 21 November 2001, E.C. Vellinga 2731 (nrITS AY243641); Point Reyes NP, southern part, 25 November 2003, R. Pastorino 11-25-c (nrITS GU136184); Point Reyes NP, along Olema Trail, 31 October 2009, S.P. Schechter (coll. E.C. Vellinga 4092); Mendocino Co., Jackson State Demonstration Forest, 22 November 2003, E.C. Vellinga 3128. Hendy Woods SP, 25 November 2002, E.C. Vellinga 2887 (nrITS GU136189). Navarro River Redwood SP, 25 November 2002, E.C. Vellinga 2903 and 2904. San Mateo Co., San Francisco Watershed, 8 December 2000, E.C. Vellinga 2587 (nrITS AY243642); ibidem, 23 December 2002, E.C. Vellinga 2974; ibidem, 25 February 2003, E.C. Vellinga 3053 (nrITS GU136187); ibidem, 5 December 2003, E.C. Vellinga 3159; ibidem, 25 November 2008, E.C. Vellinga 3938 (nrITS GU136183). San Mateo County Memorial Park, 4 November 2004, E.C. Vellinga 3219 (nrITS GU136186) and 3223 (nrITS GU136185). Moss Beach, 27 February 2001, F. Stevens (coll. E.C. Vellinga 2615) (nrITS AY243640); ibidem, 10 March 2001, E.C. Vellinga 2619 (nrITS AY243637); ibidem, 11 January 2002, E.C. Vellinga 2828 (nrITS GU136188); 28 January 2003, E.C. Vellinga 3029 and 3030.

COMMENTS — *Lepiota fuliginescens* is very closely related to the European species *La. badhamii* (FIG. 1). Morphologically the two are very similar, with only the spores of *L. fuliginescens* slightly smaller than those of *La. badhamii*. The differences in sequence data and in distribution warrant the recognition of two species. The sequence (GQ329056) from a collection in the Museo di Storia Naturale in Venice (MCVE), labeled *La. badhamii*, represents a different, unknown, species.

Lepiota fuliginescens is quite variable, both in macroscopic characters and in shape and size of the elements of the pileus covering. The two groups within *L. fuliginescens* that can be distinguished based on nrITS sequences (FIG. 1) are not characterized by any corresponding morphological characters, though one of the two groups based on nrITS sequences seems to be characterized by short elements in the pileus covering, whereas the sizes of the pileus covering elements in the second group are very variable.

Lepiota fuliginescens and *La. badhamii* differ from the other species in section *Piloselli* by the combination of relatively big basidiocarps, a trichodermal pileus

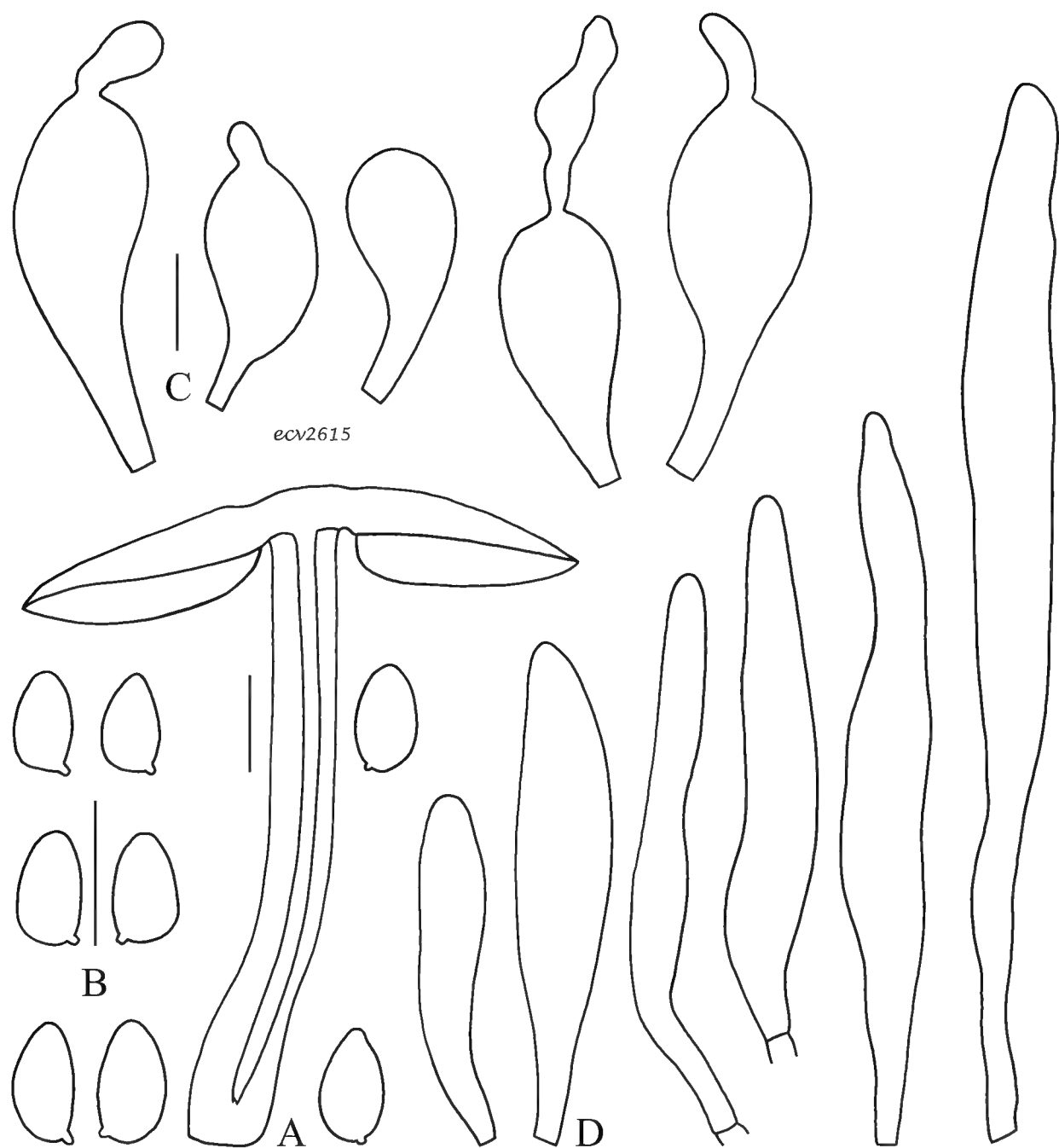


FIG. 5. *Lepiota fuliginescens* — A. Basidiocarp; B. spores; C. cheilocystidia; D. elements of pileus covering (all from ecv2615). Scale bar 10 mm (A); microscopic features 10 μ m.

covering, clavate cheilocystidia with an apical excrescence, and amygdaliform to ellipsoid spores. The young specimens are very pale, but darken rapidly. *Leucoagaricus georginae*, reported from Washington, is much smaller with cystidioid elements on the pileus, but shares the cystidial characters with *L. fuliginescens*.

The type collection of *L. roseifolia* Murrill turned out to have clavate cheilocystidia with an apical excrescence (Vellinga et al. 2010), just like those of *L. fuliginescens*, but the lamellae of the dried specimen were not as dark coloured as those of *L. fuliginescens*. Modern day interpretations of *L. roseifolia* depict it as a different species, with clavate, non-appendiculate, cheilocystidia;

that species has recently been described as *La. erythrophaeus* (Vellinga et al. 2010). Sundberg (1967) recorded the cheilocystidia of *L. roseifolia* as clavate and elongate clavate, sometimes rostrate. He might have included *L. fuliginescens* in this description of *L. roseifolia*, a species otherwise lacking in his overview of lepiotaceous fungi in California.

Lepiota fuliginescens is known from a range of habitats, and is not, like *La. cupresseus*, restricted to habitats dominated by *Callitropsis macrocarpa*.

2. *Leucoagaricus cupresseus* (Burl.) Boisselet & Guinb., Bull. Féd. Ass.

mycol. médit., n.s. 19: 34. 2001.

FIGURES 6 & 7

= *Lepiota cupressea* Burl., Mycologia 37: 53. 1945.

TYPE STUDY — Sundberg (1976: 381–383).

SELECTED DESCRIPTIONS — Boisselet & Guinbertau (2001: 35–36); Burlingham (1945: 53–54).

PILEUS 30–120 mm, convex, irregularly convex, truncate convex when young, expanding to plano-convex with central depression with or without low broad umbo, often a bit irregular, at centre with pink-brown (5–7.5 YR 6/3–4 when young, later 7.5 YR 5/4) tufty-tomentose covering, around centre breaking open and more scaly-tufty, and with age in outer $\frac{1}{4}$ of radius radially arranged and streaked, darker to dark brown with age and with rain, on white background, when scratched turning red (both covering and background); margin exceeding lamellae for more than 2 mm in young specimens. LAMELLAE, L = 100–150, l = 0–3, crowded to very crowded, free and up to 6 mm from stipe, not ventricose, up to 10 mm wide, white at first, cream-white with age, with white cystidiose edge which turns dark brown with age, and immediately orange when damaged. STIPE 50–140 \times 7–25 mm, cylindrical, in most specimens with big bulbous base, 25–50 mm wide, white at first, longitudinally innately fibrillose, often white-tomentose at base, shiny, orange when scratched or handled, turning ugly dark brown, hollow, protruding into pileus in some specimens. ANNULUS with ascending or descending white cuff, often relatively long, with small flaring white dull-tomentose part with thickened rim, changing orange when touched and turning dark brown with age. CONTEXT in pileus thick, white and dull, not changing colour when cut, except where knife stuck on pileus covering and there orange-red, in stipe white and orange in places, in younger specimens especially strongly orange-red in bulb, brownish in bulb in older specimens. SMELL indistinct, fungoid to slightly astringent. SPORE PRINT white.

CHEMICAL TESTS — KOH 3% on lamellae green to greenish.

DRIED SPECIMENS with dark lamellae.

BASIDIOSPORES [210,14,14] in side view $6.1\text{--}9.3 \times 3.9\text{--}5.4\text{ }\mu\text{m}$, $\text{avl} \times \text{avw} = 6.7\text{--}7.5 \times 4.1\text{--}4.7\text{ }\mu\text{m}$, $Q = 1.4\text{--}2.0$, $\text{av}Q = 1.53\text{--}1.69$, ellipsoid to oblong, amygdaliform,

some with faint papilla, in frontal view ellipsoid to obovoid, uni-guttulate, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA $16\text{--}28 \times 6.0\text{--}8.5 \mu\text{m}$, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $23\text{--}89 \times 6.0\text{--}16 \mu\text{m}$, variable in shape, clavate, fusiform-clavate, lageniform-utriform, cylindrical, some lageniform with rather abrupt excrescence, or with subcapitate apex, with dark granules and contents in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING trichodermal with upright elements arising from a cutis of repent brown incrustated hyphae; upright terminal elements $(50\text{--})80\text{--}350 \times 8.0\text{--}20 \mu\text{m}$, in some collections in the smaller ranges, in others long and slender, cylindrical to narrowly fusiform, with parietal brown pigment, especially in lower half of the cells. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — Growing solitarily or in small groups under *Callitropsis macrocarpa* and always close to the coast, in west facing groves and under trees planted as wind breaks etc., known from Pacific Grove and Point Lobos in Monterey Co., northward to San Francisco and the Berkeley Marina on the San Francisco Bay; occasionally in kitchen gardens and on compost heaps. December-March.

COLLECTIONS EXAMINED — U.S.A., California, Alameda Co., Berkeley, Berkeley Marina, 17 December 2002, leg. T.D. Bruns & P. Boynton (coll. E.C. Vellinga 2950); ibidem, 22 December 2002, E.C. Vellinga 2958; ibidem, 30 January 2003, E.C. Vellinga 3041 & 3042; ibidem, 28 February 2004, E.C. Vellinga 3204 (nrITS GQ258477); ibidem, 9 January 2005, E.C. Vellinga 3339; ibidem, 15 December 2006, E. C. Vellinga 3538 & 3539; Berkeley, Keeler Ave, 5 January 2009, E.C. Vellinga 3973 (nrITS GU136195). Monterey Co., Moss Landing, Castroville Moss Landing cemetery, 13 January 2002, E.C. Vellinga 2831 (nrITS AY243628), 2832 (nrITS AY243630) & 2833 (nrITS GU136194); Pacific Grove, Esplanade Park, 13 January 2002, E.C. Vellinga 2836 (nrITS GU136196) & 2841 (nrITS GU136193); unknown locality (at Fungus Fair of the Fungus Federation of Santa Cruz), 12 January 2002, E.C. Vellinga 2829 (nrITS GU139787) and 2830 (nrITS GU136192). San Francisco Co., San Francisco, Sunset Blv, D.E. Desjardin 5642 (USFS); San Francisco, Land's end, 12 January 2006, D. Bojantchev (nrITS GU136191). San Mateo Co., Moss Beach, Fitzgerald Marine Reserve, 11 January 2002, E.C. Vellinga 2827 (nrITS AY243631); ibidem, 28 January 2003, E.C. Vellinga 3038.

COMMENTS — *Leucoagaricus cupresseus* has mainly been found in *Callitropsis macrocarpa* litter in coastal groves and under rows of trees planted as wind breaks. It has also been found in France, again under *C. macrocarpa*, on the Atlantic coast and in the Mediterranean area (Boisselet & Guinberteau 2001), but the one French specimen analyzed differed in nrITS sequence (Genbank accession number AY243627) from the Californian collections (Vellinga 2004b) (FIG. 1).

Leucoagaricus cupresseus is highly variable; a whole range of sizes was found in the basidiocarps growing in one row of planted cypresses (compare coll. ecv2832, and 2833; FIG. 7). The spores can vary from having a rounded apex

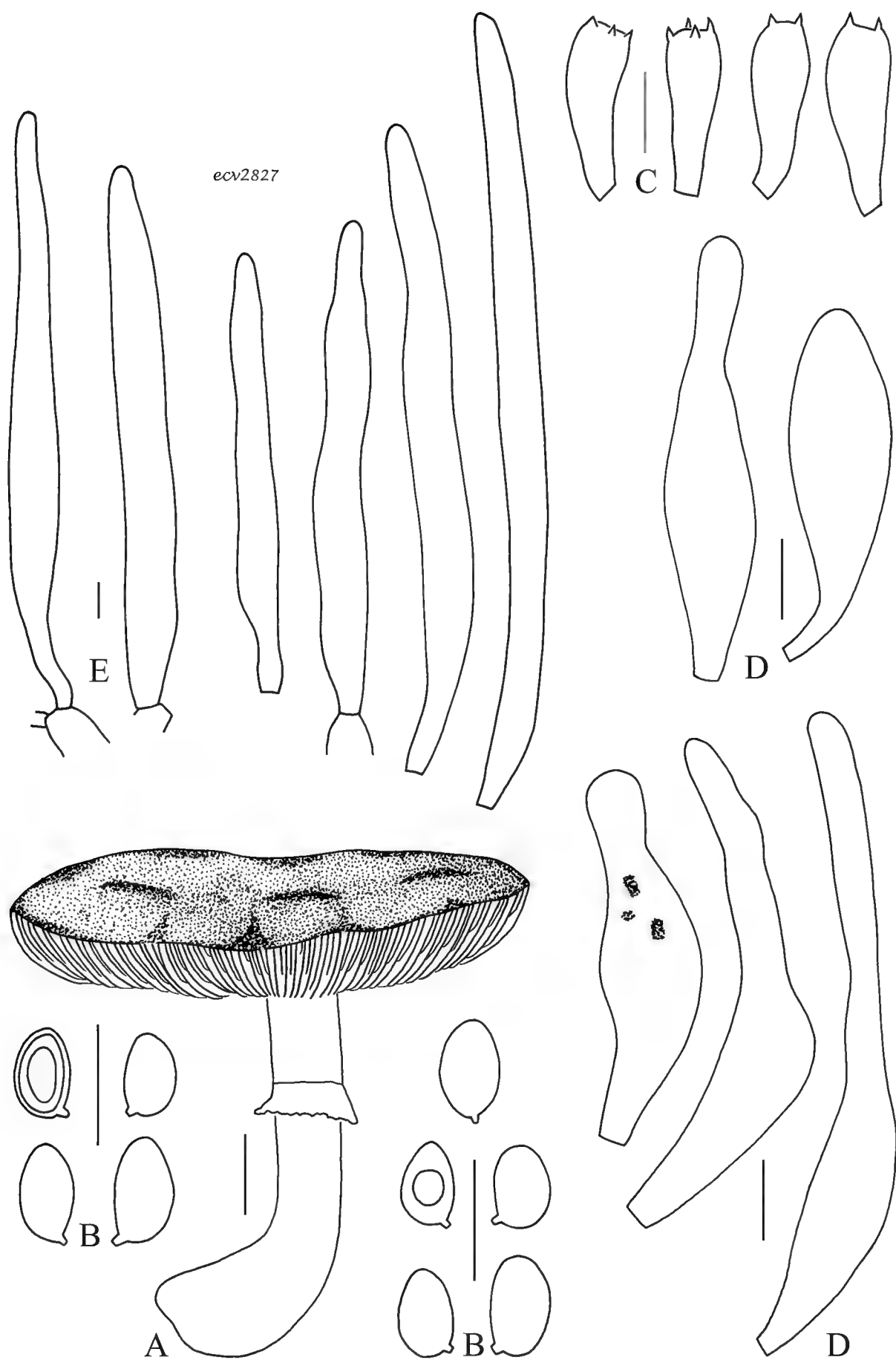


FIG. 6. *Leucoagaricus cupresseus* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from ecv2827). Scale bar 10 mm (A); microscopic features 10 μ m.

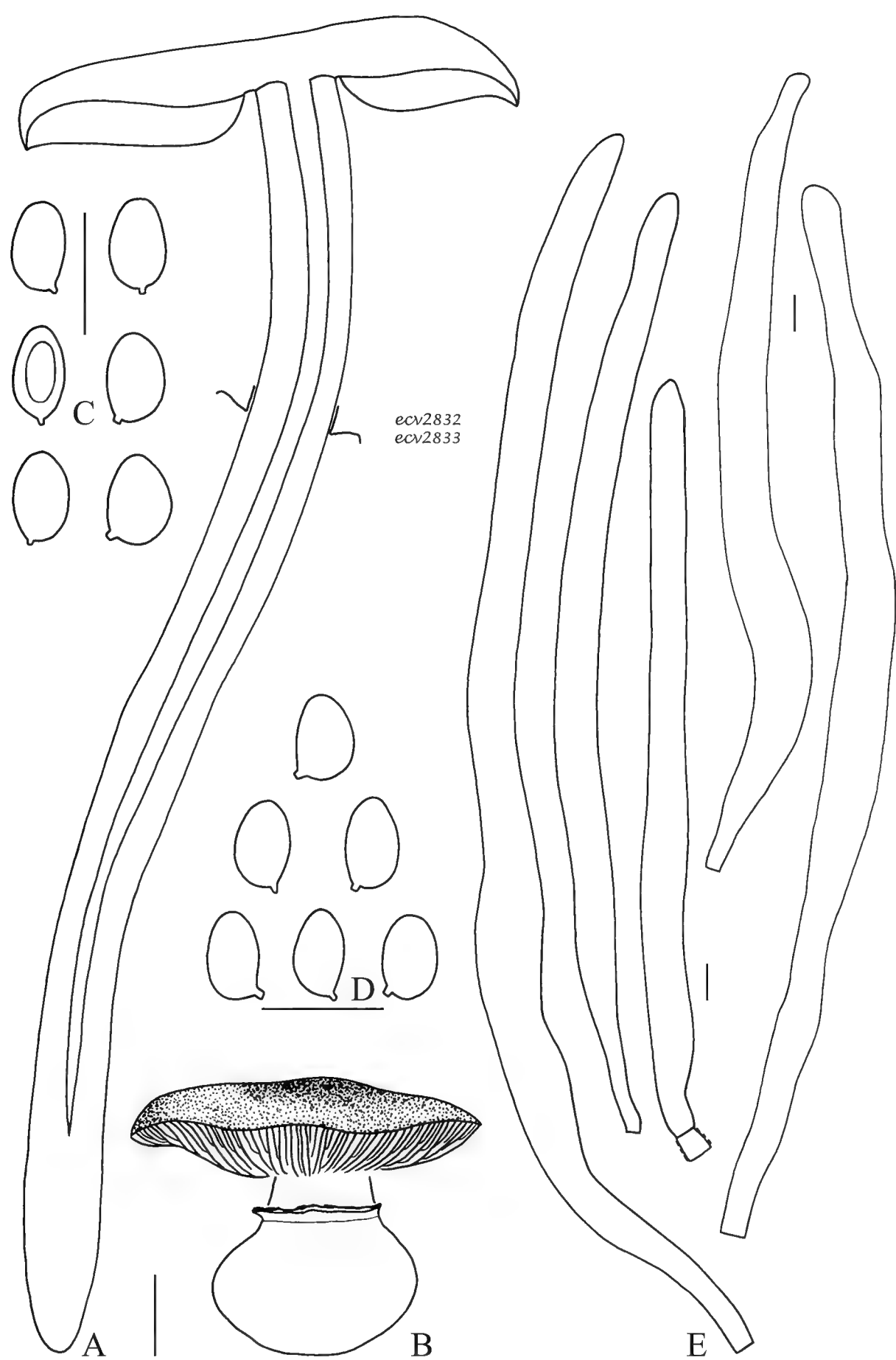


FIG. 7. *Leucoagaricus cupresseus* — Basidiocarps (A from collection ecv2833, B from ecv2832); spores (C from ecv2833, D from ecv2833); E, elements of pileus covering (from ecv2832)
Scale bar 10 mm (A); microscopic features 10 µm.

to being amygdaliform and acuminate. Shape and size of the cheilocystidia are also very variable.

In the collections studied the cheilocystidia are predominantly utriform to lageniform, and clavate cystidia occur but are in the minority. Other authors (Sundberg 1976, Boisselet 2002) reported clavate cheilocystidia as the most common type.

Leucoagaricus marginatus (Burl.) Boisselet is very close to *La. cupresseus* and might actually represent a different variant. Burlingham (1945), who described both species in the same paper, did not compare the two directly; she only compared *L. marginata* with *L. rubrotinctoides* Murrill and *L. decorata*. *Leucoagaricus marginatus* differs from *La. cupresseus* in the pale reddish lilac pileus center (Burlingham 1945), and both are similar in stature and microscopical characters. Sundberg (1976), who studied the type collections of the two species, did not comment on their differences or taxonomic placement. Boisselet (2002) listed differences between two French species identified by him as *La. cupresseus* and *La. marginatus* respectively. The differences are gradual and some might be weather or age dependent, such as the differences in the ammonia reaction. The spores in the type collection of *La. cupresseus* are more amygdaliform than in *La. marginatus* and the elements of the pileus covering in *La. cupresseus* are more attenuated towards apex than in *La. marginatus* (Sundberg 1976).

Leucoagaricus pseudopilatianus Migl. et al. and its varieties *roseodiffractus* Migl. & Resta and *rugosoreticulatus* Migl. & Resta from southern Europe come very close and might well be identical to the French collections of *La. cupresseus* (Migliozzi et al. 2001, Migliozzi & Resta 2001). *Leucoagaricus pseudopilatianus* is a rather robust pale pink brownish species, with rounded (not attenuated), upright elements in the pileus covering, clavate cheilocystidia and amygdaliform spores with an indistinct apical papilla; the basidiocarps turn black on drying. This species was described at the same time that Boisselet & Guinberteau (2001) and Boisselet (2002) reported the French occurrences of *La. cupresseus* and *La. marginatus*.

The type collection of *Leucoagaricus cupresseus* was collected in the cypress groves of Point Lobos, south of Monterey, on the Pacific coast (Burlingham 1945). This is one of the two places in the world where *Callitropsis macrocarpa* occurs in native, not planted, groves (the other being just north of Point Lobos along the '17 Mile drive', also along the coast). *Callitropsis macrocarpa* has been planted in many parts of the world, but the occurrence of a species identical to or very closely related to *La. cupresseus* has only been confirmed for France (Boisselet & Guinberteau 2001, Boisselet 2002). Data on the mycoflora of cypress-dominated landscapes are lacking for other regions.

3. *Leucoagaricus adelphicus* Vellinga, sp. nov.

FIGURES 8 & 9

MYCOBANK MB 515363

Leucoagarico pilatiano similis, sed sine odore ligni cedri, etiam in nucleari spatii interne transcripti ("nrITS") ordine differt.

HOLOTYPE — "U.S.A., California, San Mateo County, San Francisco watershed, 8 Dec 2002, E.C. Vellinga 2584 (UC)." (nrITS AY243623).

ETYMOLOGY: *adelphicus* is the Latinized form of the Greek word ἀδελφικός, brotherly or sisterly, because of the closeness to *La. pilatianus*.

PILEUS 32–55 mm, plano-convex with or without broad low umbo to plano-concave with age, pale brown to brown, pinkish brown or orange-brown, (5 YR 5/3–4, 5 YR 4/3, 7.5 YR 7–6/4–6) to slightly darker at umbo than at rest of pileus, rather evenly coloured over pileus or with radiating streaks of colour on pale cream background, or much paler at margin (up to 5 YR 8/2–3), velvety tufty all over, and those tufts more crowded at centre than at margin; pileus surface when scratched slightly orange discolouring; margin conspicuously lighter than rest of pileus and fringed, exceeding lamellae. **LAMELLAE** moderately crowded to very crowded, 1(–3) lamellulae in between 2 lamellae, free and remote from

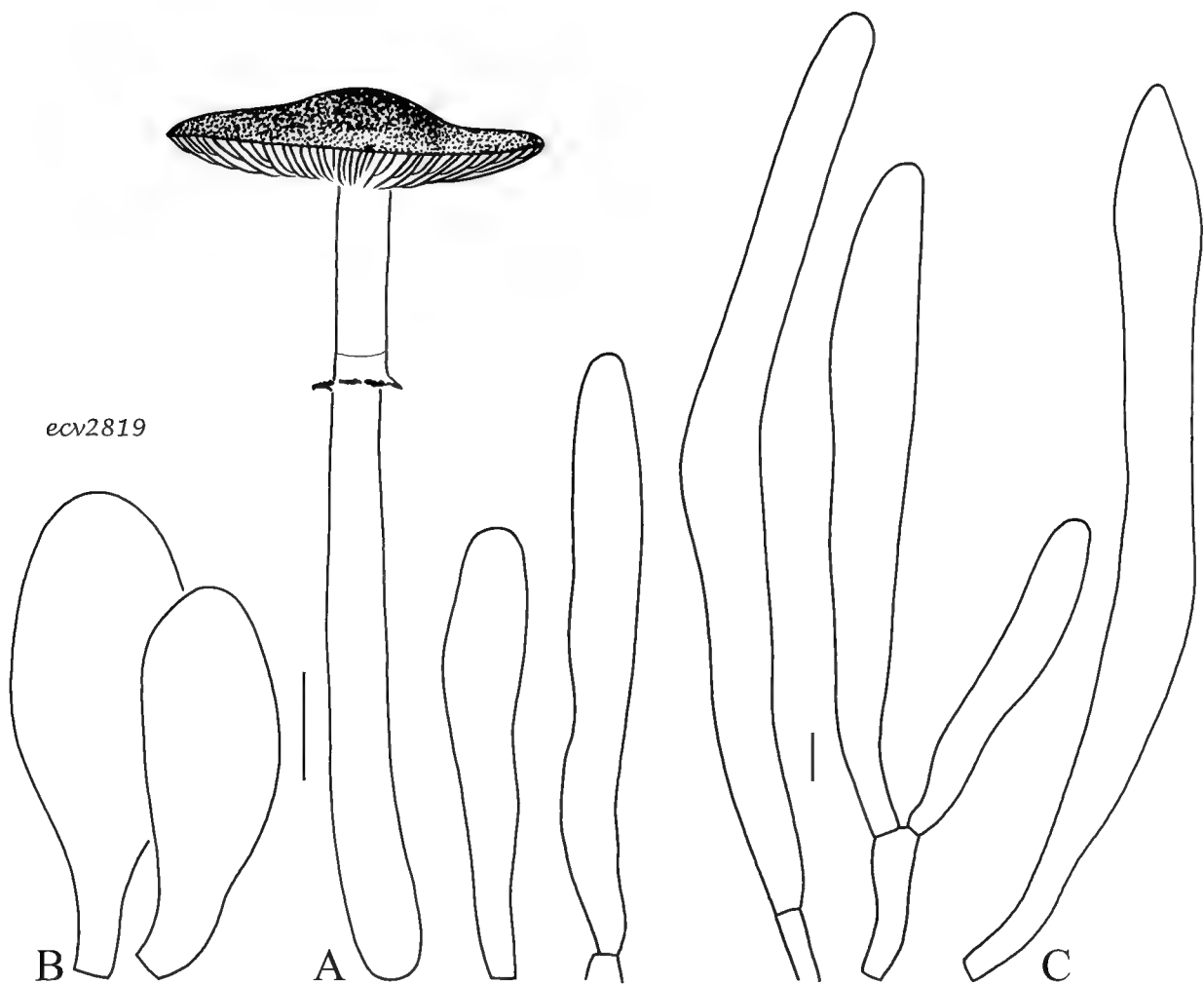


FIG. 8. *Leucoagaricus adelphicus* — A. Basidiocarp; B. cheilocystidia; C. pileus covering elements (all from ecv2819). Scale bar 10 mm (A); microscopic features 10 μ m.

stipe, subventricose to ventricose up to 4 mm wide, white but slightly yellowish-pinkish, not changing colour on damaging, with white eroded cystidiose edge. STIPE 50–80 × 5–9 mm, cylindrical but in most specimens slightly widened at base, in upper part whitish with pinkish sheen, in lower half orange-brown from touching, white tomentose at base, hollow. ANNULUS an ascending or descending cuff with a small flaring part, white with dark rim. CONTEXT in pileus white and dull, rather thick, at centre orange-red from cutting, in stipe cortex white to pale brown and shiny. SMELL none, fungoid to astringent.

LAMELLAE of dried specimens not discoloured, pale.

BASIDIOSPORES [75,5,5] in side view $5.9\text{--}7.6 \times 3.4\text{--}4.4 \mu\text{m}$, $avl \times avw = 6.2\text{--}6.6 \times 3.9\text{--}4.0 \mu\text{m}$, $Q = 1.43\text{--}1.89$, $avQ = 1.58\text{--}1.66$, ellipsoid to oblong with round apex and flattened abaxial side, in frontal view ellipsoid to oblong and symmetrical, thick-walled, smooth, without germ pore, with guttule, congophilous, dextrinoid, metachromatic in Chresyl blue. BASIDIA $17\text{--}28 \times 6.5\text{--}13 \mu\text{m}$, most 4-spored, a few 2-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $20\text{--}52 \times 6.5\text{--}16 \mu\text{m}$, clavate, broadly clavate, narrowly clavate, some narrowly utriform to cylindrical, with brown pigment and inclusions in ammonia. PLEUROCYSTIDA absent. PILEUS COVERING resembling a felted mat, trichodermal with upright elements, either solitary or in tufts, $77\text{--}317 \times 9\text{--}20 \mu\text{m}$, rarely not exceeding $200 \mu\text{m}$ in length, widest at 1/4 or 1/3 of length, and tapering towards apex, rarely blunt and relatively wide, with middle brown parietal pigment, but pale at tips. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — Solitary or in small groups, terrestrial and saprotrophic, in plantations of *Callitropsis macrocarpa*, in woods of *Quercus agrifolia* Nee, in *Eucalyptus* plantings, or in mixed conifer-broadleaf forests of central coastal California, November to January.

ADDITIONAL COLLECTIONS EXAMINED — U.S.A., California, Alameda Co., Oakland, 15 November 2001, D. Viess & D. Rust (coll. E.C. Vellinga 2669) (nrITS AY243622); Contra Costa Co., Tilden Regional Park, 26 November 2000, E.C. Vellinga 2558 (nrITS AY243621); ibidem, 4 December 2001, E.C. Vellinga 2772 (nrITS AY243624); ibidem, 6 January 2002, E.C. Vellinga 2819 (nrITS AY243625). San Mateo Co., San Francisco Watershed, 5 December 2003, E.C. Vellinga 3153 (nrITS GQ258478); ibidem, 1 December 2006, E.C. Vellinga 3532A (nrITS GU136190).

COMMENTS — *Leucoagaricus adelphicus* is morphologically and molecularly close to the European species *La. pilatianus* (Demoulin) Bon & Boiffard with which the following characters are shared: a warm brown, plushy-velvety-tomentose pileus surface, pale lamellae in dried specimens, basidiocarps not changing much colour on aging or when scratched; cheilocystidia clavate, and pileus covering made up of erect long, tapering elements. *Leucoagaricus adelphicus* lacks the typical cedar wood smell of *La. pilatianus*, and differs considerably in nrITS sequences from *La. pilatianus*.

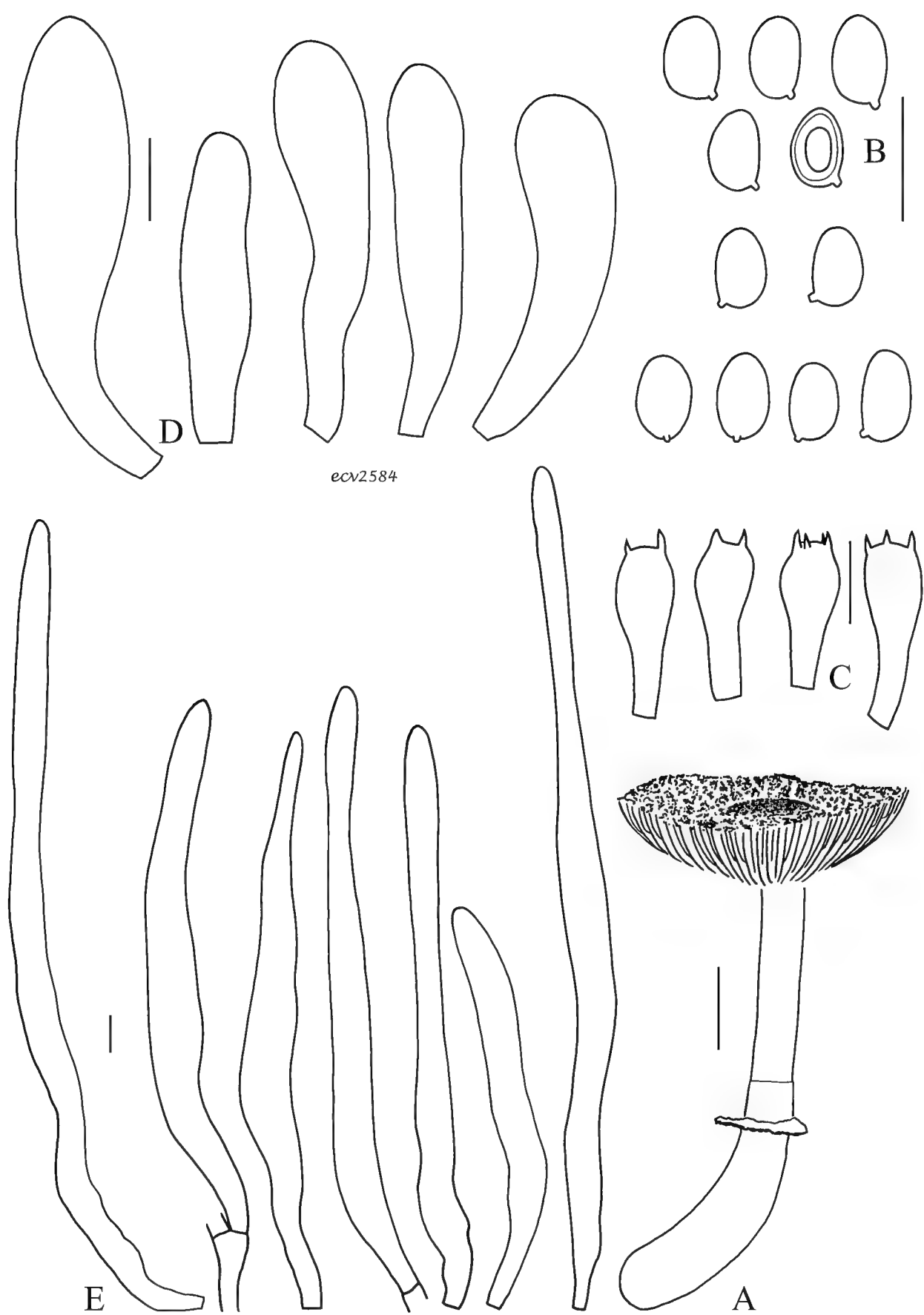


FIG. 9. *Leucoagaricus adelphicus* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from holotype, collection ecv2584).
Scale bar 10 mm (A); microscopic features 10 μ m.

The name *Lepiota pulverapella* Zeller was at first considered for the taxon here described as *La. adelphicus*, but that species differs in the robust fruitbodies (also with warm brown colours), its habitat (in a field; Zeller 1933), and in the pileus covering structure and cheilocystidial shape (Sundberg 1995). Habitat, basidiocarp size, and structure of the pileus covering make this an enigmatic species. The context staining yellow when bruised (Zeller 1933) almost suggests a relationship with *La. americanus*, but that species has bigger spores with a germ pore. Zeller (1933) described the lamellae as ‘drying a flesh color with darker rosy and vinaceous tinges,’ characters absent from *La. adelphicus*. Unfortunately, Sundberg (1995) in his type study did not place the species in a phylogenetic or taxonomic framework or compare it to other described species.

Somewhat similar species are *La. hesperius* and *La. dyscritus*. The former differs in the lamellae that discolour on drying, while the latter shares the pale lamellae but differs in the structure of the pileus covering, which is made up of upright chains of relatively short elements. All three species can fruit at the same time in the Monterey cypress grove of the San Francisco watershed south of San Francisco.

Leucoagaricus adelphicus differs from *L. fuliginescens* in the absence of an apical excrescence on the cheilocystidia and the pale colours of the lamellae in dried basidiocarps.

The similar *Leucoagaricus aurantiovergens* A. Gennari & Migl. has longer spores (avQ = 2) and relatively wide elements of the pileus covering (Gennari & Migliozi 1999). It stains immediately orange on the stipe when bruised. The cheilocystidia are clavate.

A third species from southern Europe, *Leucoagaricus pseudopilatianus*, resembles *La. cupresseus* much more than *La. adelphicus*. Migliozi & Resta (2001), who published a key to the European species with clavate cheilocystidia, unfortunately did not include *La. cupresseus* and *La. marginatus* in their treatment and discussions.

4. *Leucoagaricus hesperius* Vellinga, sp. nov.

FIGURE 10

MYCOBANK MB 515366

Prope *Leucoagaricum adelphicum* et *La. pilatianum*, *lamellis rubescentibus differt.*

HOLOTYPE — “U.S.A., California, San Mateo County, San Francisco Watershed, 1 December 2006, E.C. Vellinga 3515 (UC)”, (nrITS GU139788).

ETYMOLOGY: *hesperius* is the Latinized form of the Greek word ἑσπεριος meaning ‘evening-’ and ‘western’.

PILEUS 30–53 mm, convex to plano-convex with slightly depressed centre, and sometimes with low umbo in centre, plano-concave or wavy with age, evenly pinkish-reddish brown (5–7.5 YR 6–5/4–6), or at centre more dark orange-brown (5 YR 4/6–5/6) and orange-brown around centre, plushy tufty-velutinous all

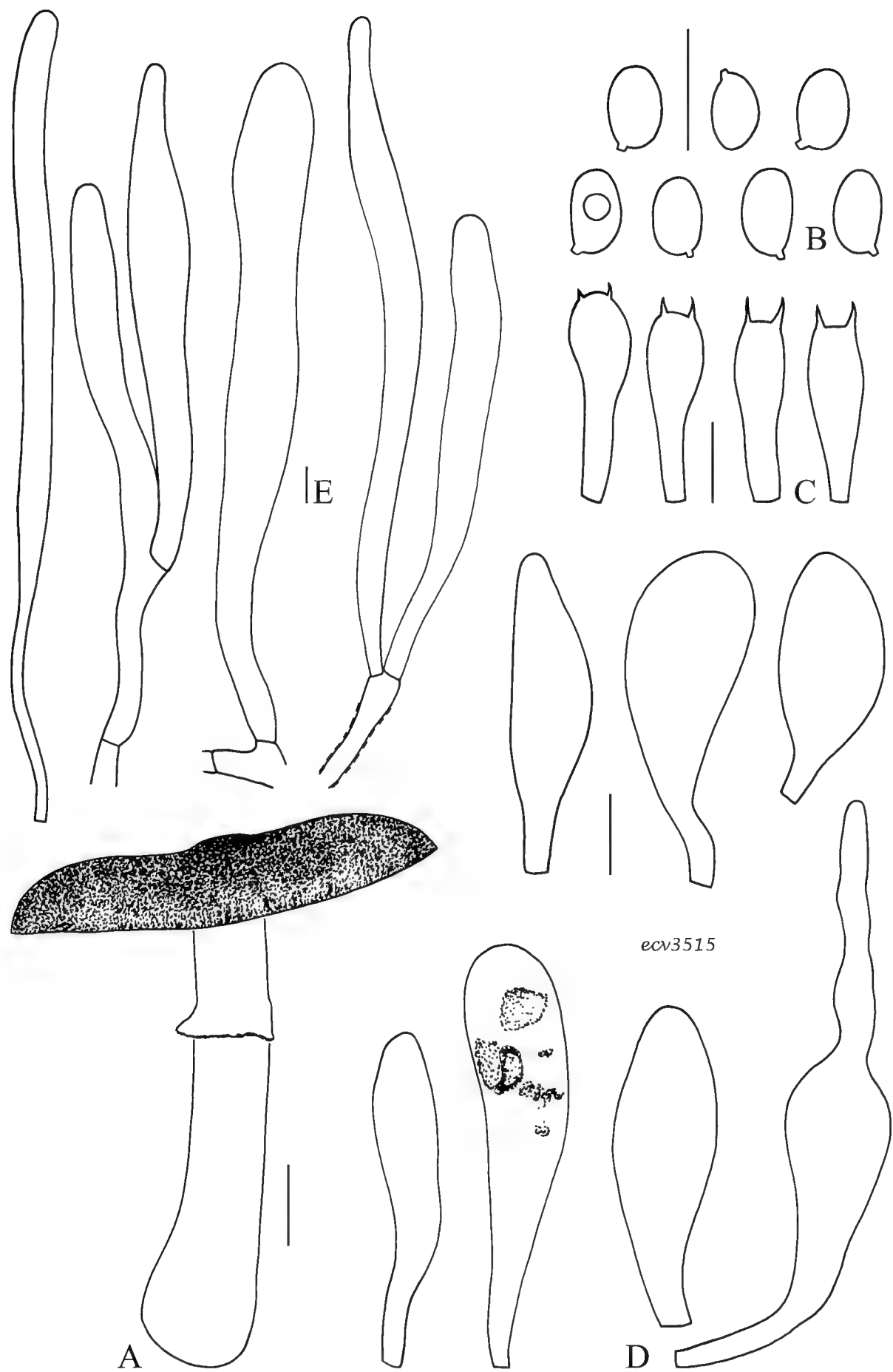


FIG. 10. *Leucoagaricus hesperius* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from holotype, collection ecv3515).
Scale bar 10 mm (A); microscopic features 10 μ m.

over, though closed at centre, and on background of radially arranged covering, on a white background; margin cream and exceeding lamellae. LAMELLAE crowded to rather crowded, free and 1 mm remote from stipe, ventricose to segmentiform, 3–4.5 mm wide, whitish creamy, with age more orange coloured cream, with white cystidiose edge, turning red to almost black with pressure. STIPE 35–77 × 6–10 mm, slightly narrower at apex, widened at base to 14 mm, whitish at utmost apex, pale pinkish-brownish to brownish from handling and with age lower down, innately lengthwise fibrillose, and with fibrils blackening on stipe, hollow. ANNULUS a descending cuff with ragged upper tear and small flaring part, white with dark brown rim. CONTEXT dull, white and thick in pileus, white shiny in stipe. SMELL rather indistinct, vaguely like the rubber smell of *L. cristata*.

CHEMICAL TESTS – Ammonia 10% on pileus, annulus, and lamella edge green; no reaction on surface of lamellae.

DRIED SPECIMENS with medium to dark pink lamellae.

BASIDIOSPORES [70,3,3] in side-view 5.9–8.0 × 3.5–4.7 µm, avl × avw = 6.2–7.1 × 3.8–4.2 µm, Q = 1.3–1.85, avQ = 1.48–1.69, ellipsoid to oblong, with rounded apex, with adaxial side almost straight, and abaxial side convex, in frontal view ellipsoid to oblong, uniguttulate, with smooth thick wall, without a germ pore, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA 21–28 × 6.5–9.0 µm, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA 31–73 × 8.5–16 µm, clavate, narrowly clavate, a few fusiform, some with long neck or excrescence (sizes included in measurements), with brown, evenly distributed intracellular pigment in ammonia and sometimes with dark irregular granular contents. PLEUROCYSTIDIA absent. PILEUS COVERING trichodermal with upright brown-walled elements, some articulated, but most upright elements single-celled; terminal elements 95–325 × 7.5–25 µm, with narrowed rounded apex; pigment brown to pale brown, parietal but also exuding in ammonia, and encrusting in connecting hyphae. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — In small groups, terrestrial in cypress duff in east facing *Callitropsis macrocarpa* plantation, only known from one locality south of San Francisco. December.

ADDITIONAL COLLECTIONS EXAMINED — U.S.A., California, San Mateo County, San Francisco Watershed, 13 December 2002, E.C. Vellinga 2939 (nrITS GU139789); ibidem, 2 December 2005, E.C. Vellinga 3429, 3430, 3431 (nrITS GU139790).

COMMENTS — *Leucoagaricus hesperius* resembles *La. pilatianus* and *La. adelphicus* but reacts more strongly when damaged, especially on the lamellae.

Leucoagaricus hesperius shares the reactions of the lamellae on drying with *L. pulverapella*, which is differentiated by a pileus covering made up of short elements (Sundberg 1995).

5. *Leucoagaricus dyscritus* Vellinga, sp. nov.

FIGURES 11 & 12

MYCOBANK MB 515365

Leucoagarico adelphico similis lamellis dilutis non-tinctis, pilei tegumento partibus brevibus aggregatis differt.

HOLOTYPE — “U.S.A., California, San Mateo County, San Francisco Watershed, 5 December 2008, E.C. Vellinga 3956 (UC)”, (nrITS GU136180).

ETYMOLOGY: *dyscritus* is the Latinized form for the Greek δυσκριτος, which means ‘difficult to distinguish’; it sounds confusingly similar to the word discrete.

PILEUS 20–35 mm, convex with small umbo, velvety to tufty-velvety at centre, dark reddish brown (5 YR 3/4, 4–3/3), around centre with very small radially arranged pinkish brown to reddish brown, (5 YR 4–5/4–6) pyramidal tufts on white to whitish background, very pale at margin and slightly exceeding lamellae, with pressure at margin blackish discoloured. **LAMELLAE** crowded to very crowded, free and remote (up to 1 mm) from stipe, subventricose to segmentiform up to 3 mm wide, whitish with white cystidiose edge. **STIPE** 50–90 × 4–6(–8) mm, slender and cylindrical or laterally compressed, slightly wider at utmost base, white or whitish shiny, discolouring reddish orange

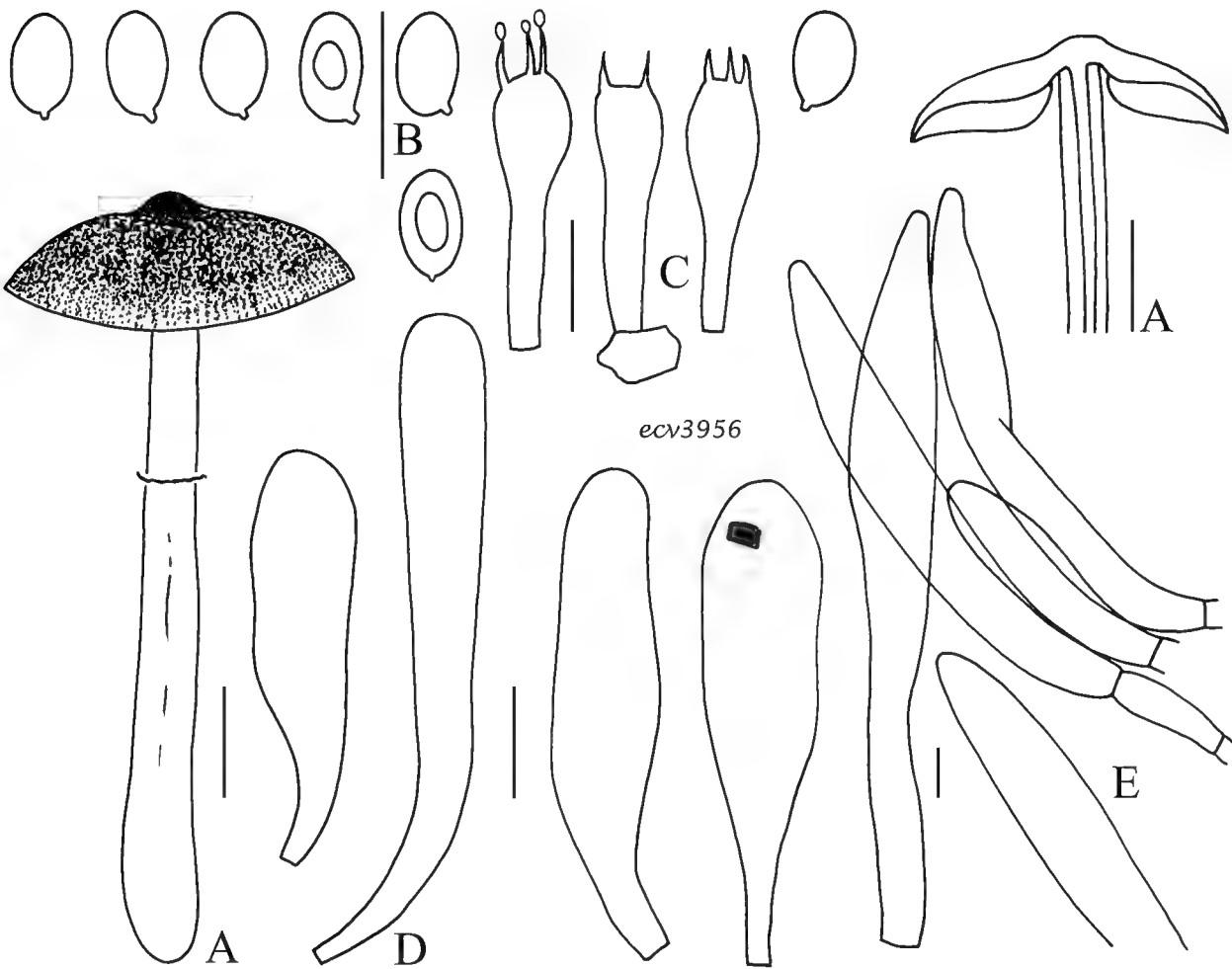


FIG. 11. *Leucoagaricus dyscritus* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from holotype, collection ecv3956).

Scale bar 10 mm (A); microscopic features 10 µm.

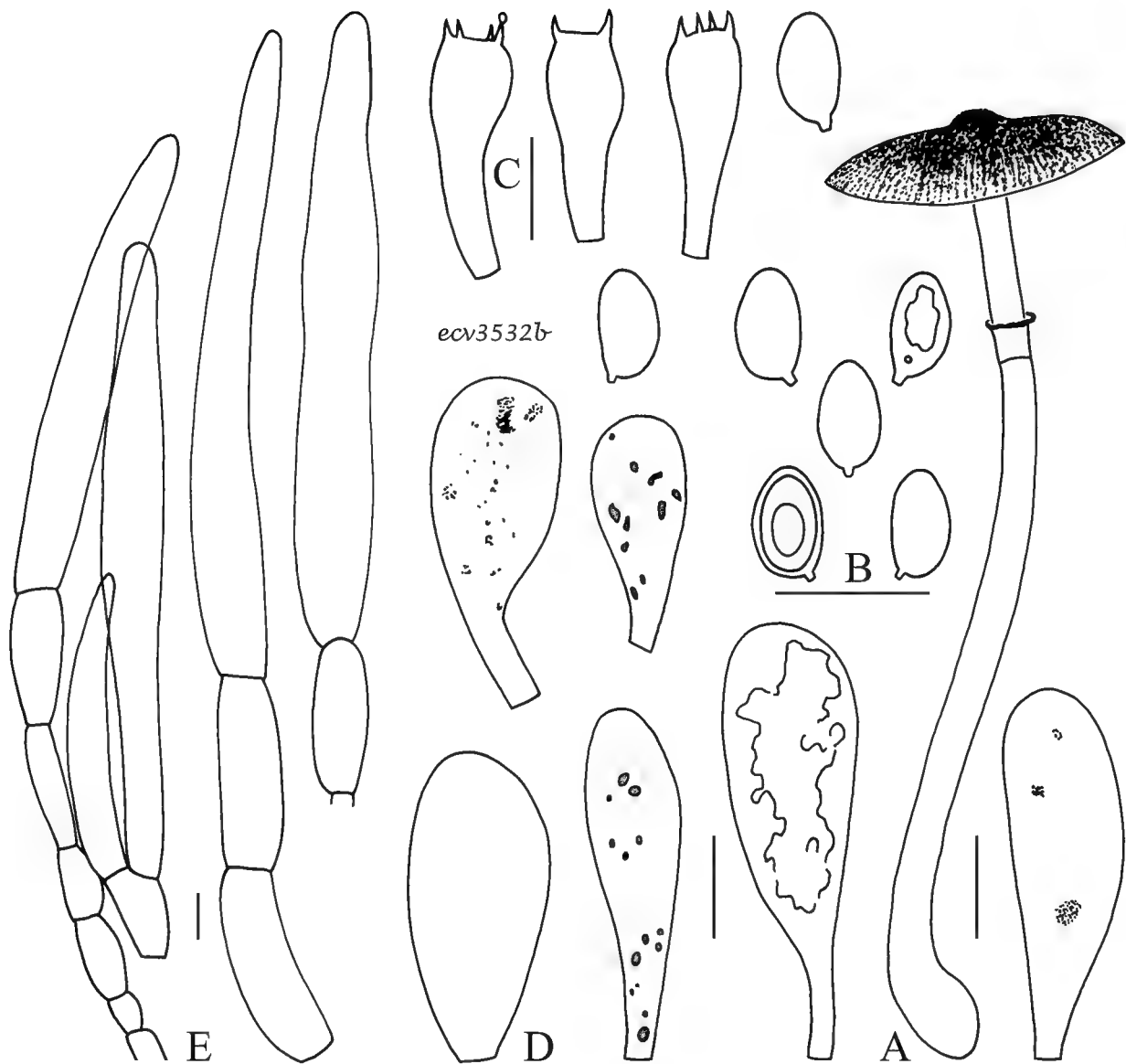


FIG. 12. *Leucoagaricus dyscritus* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from ecv3532B). Scale bar 10 mm (A); microscopic features 10 μ m.

where handled, with dark hairs in lower part, protruding into pileus, hollow. ANNULUS an ascending cuff and a small flaring part, or just only a funnel-shaped flaring part, white with contrasting very dark to black rim. CONTEXT dull and white, quite thick, in pileus, white shiny in stipe. SMELL cacao-like fungoid and slightly astringent.

DRIED SPECIMENS with light lamellae, without any trace of pink.

BASIDIOSPORES [80,5,5] in side view $5.1\text{--}8.0 \times 3.4\text{--}4.7 \mu\text{m}$, $\text{avl} \times \text{avw} = 5.8\text{--}7.2 \times 3.7\text{--}4.1 \mu\text{m}$, $Q = 1.45\text{--}2.05$, $\text{avQ} = 1.56\text{--}1.82$, ellipsoid to oblong, with rounded apex, in some specimens amygdaliform, in frontal view ellipsoid to oblong, thick-walled, smooth, without germ pore, uniguttulate, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA $20\text{--}25 \times 6.5\text{--}10.0 \mu\text{m}$, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $18\text{--}55 \times 5.5\text{--}15 \mu\text{m}$, clavate, narrowly clavate to almost cylindrical, fusiform, irregularly lageniform with

rather short neck (up to $14 \times 6.0 \mu\text{m}$), with dark (not brown, but grey-greenish) granules in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING trichodermal with tufts or bundles of upright hyphae, made up of up to 5 elements in a row, with the terminal elements by far the biggest, and most differentiated; terminal elements $40\text{--}170 \times 10\text{--}22 \mu\text{m}$, tapering towards apex, with brown intracellular and parietal pigment; pigment exuding in ammonia; pigment parietal and sometimes incrusting in the penultimate elements. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION – Solitary or in small groups, terrestrial, in duff of *Callitropsis macrocarpa* planting on east-facing slope, November and December. So far, known from the San Francisco Watershed, south of San Francisco.

ADDITIONAL COLLECTIONS EXAMINED — U.S.A., California, San Mateo Co., San Francisco Watershed, 10 December 1999, E.C. Vellinga 2389; 5 December 2003, E.C. Vellinga 3152 and 3155; ibidem, 6 December 2005, E.C. Vellinga 3428; ibidem, 1 December 2006, E.C. Vellinga 3532B (nrITS GU136181).

COMMENTS — *Leucoagaricus dyscritus* is characterized by non-staining lamellae and a pileus covering comprising squamules and tufts made up of short elements. In his type study, Sundberg (1995) noted that *L. pulverapella* has a similar pileus covering but differs in the much more robust basidiocarp (7–12 cm across), the pink discolouring lamellae, and its original habitat (Zeller 1933).

Similar species with an equally tomentose-velvety pileus covering that co-inhabit the same Monterey cypress grove south of San Francisco are *La. adelphicus*, with long elements in the pileus covering and non-staining lamellae, and *La. hesperius*, with discolouring lamellae and again a trichoderm made up of long elements. *Leucoagaricus* sp. (collection ecv2484) is much paler in general and has a more squamose pileus covering.

6. *Leucoagaricus erythrophaeus* Vellinga in Vellinga et al., Mycologia 102: 450. 2010 (in press; doi:10.3852/09-164).

MISAPPLIED NAME — *Lepiota roseifolia* sensu Arora (1986: 305); sensu Sundberg (1967: 115–119).

SELECTED DESCRIPTION — Vellinga et al., Mycologia 102: 450–451. 2010.

PILEUS 18–60 mm, when young hemispherical with inflexed margin, expanding via convex or widely conical to finally wavy plano-convex to slightly plano-concave, at centre with closed covering, velvety-plushy grey, dark purplish-reddish, to dark brown-black, around centre breaking open into concentrically arranged small fibrillose grayish brownish to dark brown-black squamules, often in bands, on white background, when touched immediately red-orange, changing to dark brown; margin irregular in young specimens, later evening out, exceeding lamellae. LAMELLAE free, and remote from stipe often attached

to a kind of collarium, moderately crowded to crowded, ventricose, yellowish white, with white cystidiose edge, orange when touched, at least on edge, and edge darkening after being touched. STIPE 55–70 × 4–5 mm, cylindrical in upper 2/3 and widening toward up to 15 mm wide base, pale at apex and in untouched specimens pale over complete length, when touched first orange-red, changing to blackish and dark, cystidiose or hairy-cobwebby over whole length, protruding into pileus, hollow. ANNULUS an ascending or descending small, white cuff, with a flaring part with fringed edge, turning dark on edge with age and touching. CONTEXT white to whitish in pileus, orange where cut but soon vanishing, pale cream-coloured to yellowish in stipe, and orange where cut. SMELL indistinct, astringent or lepiotoid. TASTE not known.

DRIED SPECIMENS with pink lamellae.

BASIDIOSPORES [228,13,10] in side view 5.9–8.8 × 3.5–4.9 µm, $avl \times avw = 6.2-7.4 \times 3.8-4.2$ µm, $Q = 1.4-2.05$, $avQ = 1.61-1.78$, ellipsoid to amygdaliform-ellipsoid, some oblong and subamygdaliform, in frontal view ellipsoid, relatively thick-walled, often uniguttulate, without germ pore, congophilous, dextrinoid, metachromatic in Cresyl Blue. BASIDIA 15–29 × 6.5–9.0 µm, narrowly clavate, with 4 sterigmata. LAMELLA EDGE sterile, with a continuous broad band or tufts of cheilocystidia with brown contents. CHEILOCYSTIDIA 30–75 × 8.0–14.0 µm, narrowly clavate, narrowly utriform, to irregularly cylindrical and narrowed into an often long pedicel, some bifid, with brownish contents and some dark granules in ammonia; in fresh material with green-grey contents in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING a trichoderm, towards margin more cutis-like with differentiated terminal elements; terminal elements 96–350 × 9.0–20 µm, most often tapering towards apex, sometimes with blunt and rounded apex, in some specimens with many shorter elements, in others, only with those long elements; elements brown-walled at least in lower part, sometimes also with granulose or diffuse brown contents; repent connecting hyphae with dark granulose contents, sometimes also with parietal and incrusting pigments. CLAMP CONNECTIONS absent from all tissues.

HABITAT AND DISTRIBUTION — In small groups, terrestrial, in different forests, e.g. in northern California mixed *Picea sitchensis* (Bong.) Carrière and *Tsuga heterophylla* Sarg. forests, or *Alnus rubra* Bong. and *Sequoia sempervirens* and in central coastal California *Pseudotsuga menziesii* (Mirb.) Franco with *Sequoia sempervirens* and various other tree species, throughout coastal California from Mendocino Co. northwards. Also reported from lower elevations of the western slope of the central Sierra Nevada, but actual distribution poorly known. End of October through beginning of December.

COLLECTIONS EXAMINED – U.S.A., California, Humboldt Co., Arcata, Community Forest, 9 November 2004, E.C. Vellinga 3243 (nrITS GQ258469; Holotype, UC); Patrick's Point SP, 23 October 2003, E.C. Vellinga 3081, 3082 (nrITS GQ258471) and

3083; *ibidem*, 9 November 2004, E.C. Vellinga 3248 (nrITS GQ258470) and 3254 (nrITS GQ203805); Orrick, along Davison Road, 27 October 2007, N. Nguyen NN02 (nrITS GQ258468); *ibidem*, 7 November 2009, E.C. Vellinga 4108; Marin Co., near Alpine Lake, 15 November 2005, E.C. Vellinga 3376 (nrITS GQ258472) and 3379 (nrITS GU136177); Point Reyes NP, 31 October 2009, S.P. Schechter (coll. E.C. Vellinga 4094); Mendocino Co., Jackson State Demonstration Forest, 17 November 2001, E.C. Vellinga 2691 (nrITS AY243644); Van Damme SP, 18 November 2001, E.C. Vellinga 2682 (nrITS GU136179); San Mateo Co., San Mateo County Memorial Park, 4 November 2004, E.C. Vellinga 3217; Yuba Co., Tahoe NF, Hornswoggle Campground near Bullards Bar, 9 November 2005, E.C. Vellinga 3358; south of Challenge, along Oregon Hill Road, 10 November 2005, E.C. Vellinga 3362 (nrITS GU136178).

COMMENTS — *Leucoagaricus erythrophaeus* is better known as *Lepiota roseifolia*, but the type study (Vellinga et al. 2010) revealed that *L. roseifolia* is characterized by cheilocystidia with an apical excrescence and relatively broad and short elements on the pileus covering; the dried collection also lacked dark lamellae — all characters that do not fit the modern interpretation of that name.

Leucoagaricus erythrophaeus differs from *L. flammeotincta* and allies in the staining lamellae, the pseudocollarium to which the lamellae are attached, and in particular in the structure of the pileus covering that is composed of long often erect (trichodermal) elements. In *L. flammeotincta* s.l., the pileus covering is a cutis composed of strands of repent coloured hyphae. *Leucoagaricus pardalotus* shares the trichodermal pileus covering, is smaller, and has a distinct dark and white pattern on the pileus.

Lepiota roseifolia was reported from the Great Smoky Mountains National Park (Smith & Hesler 1938), but microscopical data were lacking, and it might well represent a different species in section *Piloselli*.

Leucoagaricus decipiens Contu, Vizzini & Vellinga is the European counterpart of *La. erythrophaeus* (Vellinga et al. 2010).

7. *Leucoagaricus pardalotus* Vellinga, sp. nov.

FIGURE 13

MYCOBANK MB 515364

Lepiotae flammeotinctae similis, pilei trichodermalis tegumento, cheilocystidiis cylindricoclavatis, colore minus intense rubescenti differt.

HOLOTYPE — “U.S.A., California, Mendocino Co., Van Damme SP, Fern Creek Canyon, 21 November 2004, E.C. Vellinga 3313,” (nrITS GQ258479).

ETYMOLOGY: *pardalotus* is the latinized form of ‘παρδαλωτος’, spotted as a leopard, because of the black plushy patches and squamules on the pileus.

PILEUS 30–60 mm, convex with faint umbo, plano-convex to plano-concave with umbo, with plushy-velvety deep dark red-brown (5 YR 2.5/2, 7.5 YR 3/2) calotte, around umbo with small, dark brown v-shaped fibrillose squamules, radially arranged, often in streaks, on whitish background; outer 3 mm marginal zone sulcate and white; surface changing to faintly orange when scratched.

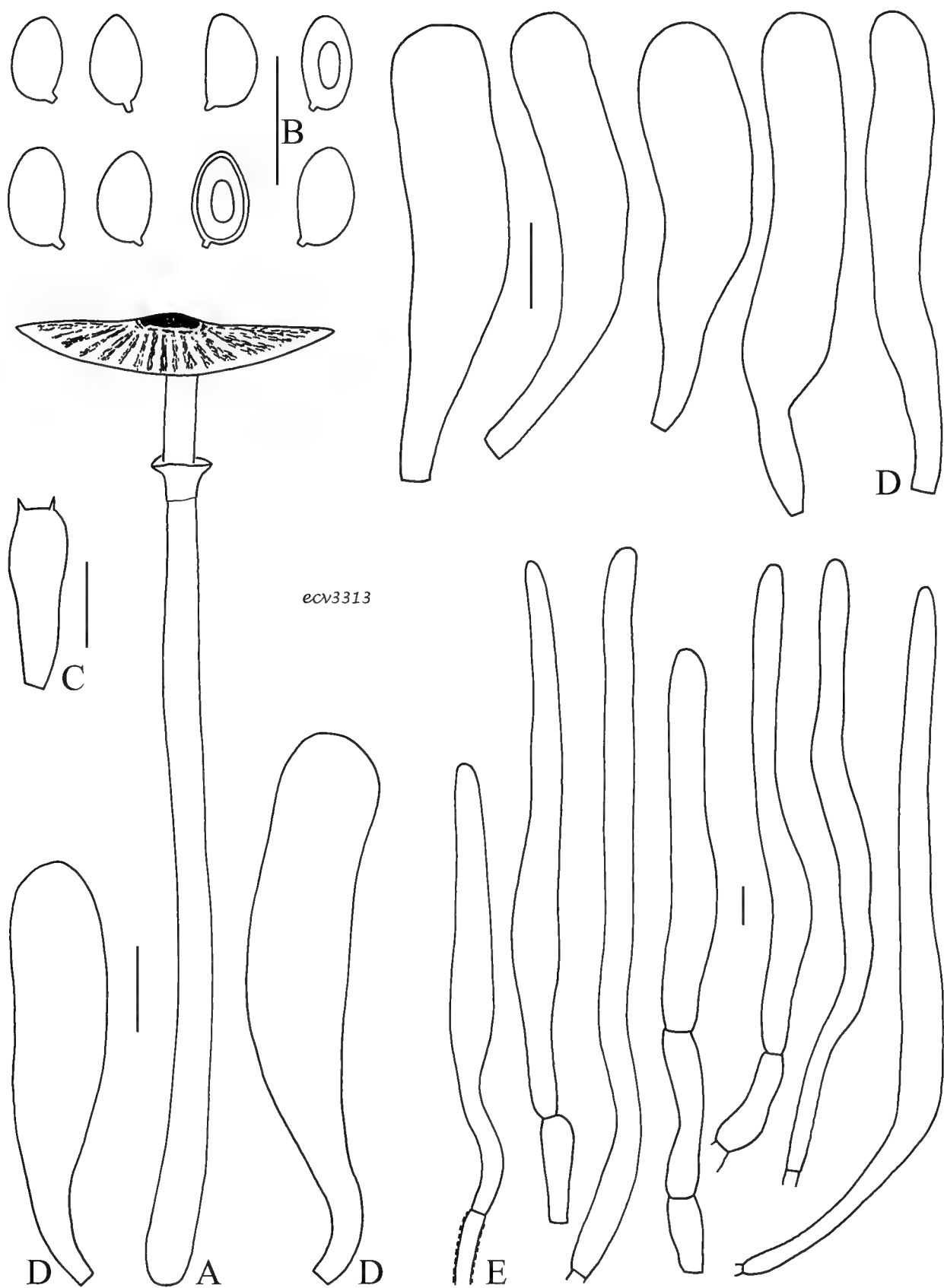


FIG. 13. *Leucoagaricus pardalotus* — A. Basidiocarp; B. spores; C. basidium; D. cheilocystidia; E. pileus covering elements (all from holotype, collection ecv3313). Scale bar 10 mm (A); microscopic features 10 μ m.

LAMELLAE moderately crowded to rather distant, free and remote from stipe, attached to a rudimentary collarium, ventricose or subventricose, cream-greyish, when cut yellow to yellow-orange, with white, distinctly cystidiose-eroded edge, where touched dark brown. STIPE 80–110 × 3–7 mm, gradually widening towards 6–9 mm wide base, pale at apex, shiny but also with cystidia, below annulus brownish, orange to orange-red when touched and turning and staying dark brown, but pale fibrils mitigating the effect, hollow. ANNULUS made up of an ascending pale cuff and a flaring part, dark brown on under side, white on upper side. CONTEXT white to pale creamy in pileus, slightly orange where cut, especially below calotte, pale brown glass-like in stipe. SMELL like the rubber component of the smell of *L. cristata*.

DRIED SPECIMENS with coloured (pinkish) lamellae, and a dark stipe.

BASIDIOSPORES [34,2,2] in side view 6.6–8.8 × 3.9–4.7 µm, $avl \times avw = 7.4\text{--}7.5 \times 4.3$ µm, $Q = 1.44\text{--}1.92(-2.14)$, $avQ = 1.71\text{--}1.74$, ellipsoid to oblong, most with straight adaxial side, some amygdaliform, in frontal view ellipsoid to oblong, uni-guttulate, without germ pore, thick-walled, congophilous, dextrinoid, metachromatic in Cresyl Blue. BASIDIA 18–23 × 7.0–8.5 µm, 4-spored. LAMELLA EDGE with tufts of cheilocystidia. CHEILOCYSTIDIA 26–65 × 8.0–12 µm, narrowly clavate, subutriform, cylindrical and attenuated towards pedicel, often a bit irregular, with brown granular contents in ammonia, but many without contents. PLEUROCYSTIDA absent. PILEUS COVERING with tufty squamules made up of erect elements, 110–325 × 7.5–12.5 µm, with rounded tips, not attenuated towards apex, with dark brown granular contents and with thickened brown walls; basal connecting hyphae with dark incrusting pigment; hyphae of pileitrama with some dark granules in ammonia. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — In small groups, terrestrial and saprotrophic, in damp places in mixed conifer forests on the north Californian coast, November. So far only found in Mendocino County.

ADDITIONAL COLLECTION EXAMINED — U.S.A., California, Mendocino Co., Jug Handle SR, 19 November 2007, E.C. Vellinga 3727 (nrITS GU136202).

COMMENTS — *Leucoagaricus pardalotus* may be taken for *L. flammeotincta* in the field, but the dense velvety plush calotte and scales and absence of the intense red discolouration on touching, distinguish it. It is one of the most beautiful species in the group. Microscopically the narrowly clavate cheilocystidia and the pileus covering made up of dense patches of upright dark brown elements set it apart from the other species.

The new species looks a bit similar to *Lepiota felina* (Pers.) P. Karst., but the absence of clamp connections, the reddening reactions, the shape of the ring, spores and cystidia all diagnose *La. pardalotus*.

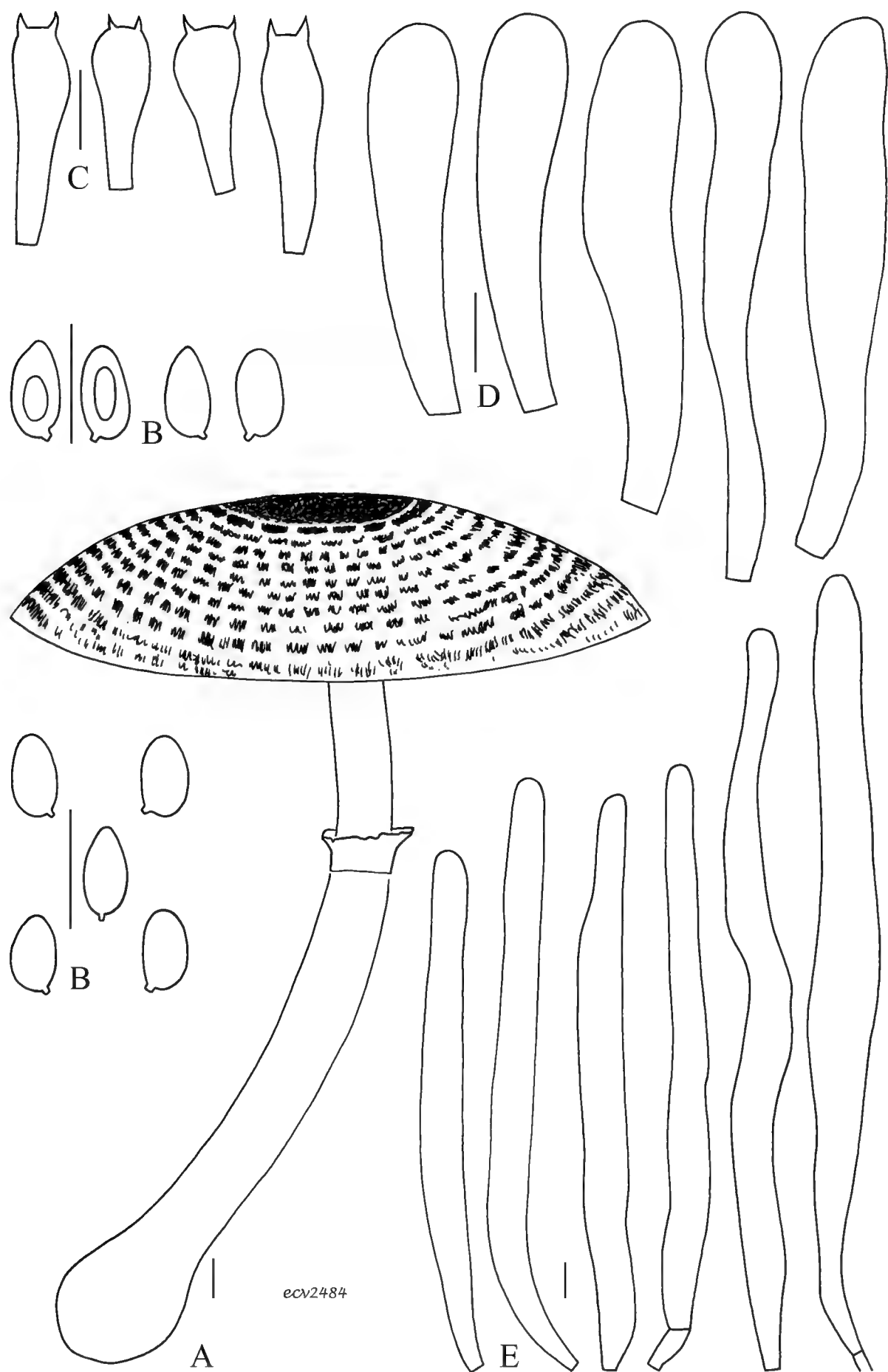


FIG. 14. *Leucoagaricus* sp. (collection ecv2484) — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering. Scale bar 10 mm (A); microscopic features 10 μ m.

8. *Leucoagaricus* sp. (collection ecv2484)

FIGURE 14

PILEUS 70 mm, plano-convex, dark red-brown (5 YR 3/3) at centre and there closed and plush-like, around centre gradually outwards breaking up into red-brown (5 YR 4/3–5/3) short-fibrillose patches on white background; margin exceeding lamellae. LAMELLAE, L = around 80, l = 1, crowded, free and close to stipe, not ventricose, white, with white-fimbriate edge discolouring dark when touched. STIPE 90 × 8 mm, cylindrical but widened at bulbous, 15 mm wide base, whitish when untouched and staying so above annulus, in lower part with dark brown short fibrils on yellow-brownish background. ANNULUS an ascending cuff with short flaring part with dark purple-brown rim. CONTEXT white, unchanging, thick in pileus, whitish in stipe. SMELL unpleasant, fungoid.

CHEMICAL TESTS — Ammonia 10% or KOH 3% on lamella edge green, remaining basidocarp non-reactive.

DRIED SPECIMEN not discoloured, pale.

BASIDIOSPORES [15,1,1] in side-view 6.0–7.9 × 3.5–4.0 µm, avl × avw = 6.8 × 3.9 µm, Q = 1.61–2.0, avQ = 1.77, oblong to subcylindrical-amygdaliform, with rounded or more pointed apex, in frontal view ovoid with pointed or rounded apex, uniguttulate, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA 21–27 × 6.5–8.5 µm, 4-spored, some, close to lamella edge, thick-walled. LAMELLA EDGE sterile. CHEILOCYSTIDIA 49–75 × 8–11 µm, narrowly clavate, rarely subutriform, without apical excrescence, green in ammonia. PLEUROCISTIDIA absent. PILEUS COVERING trichodermal, with erect dark brown, cylindrical elements, 125–240 × 11–20 µm, with rounded apex, with parietal pigment; lower, connecting hyphae with incrusting brown pigment. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — Solitary, terrestrial in duff, under *Quercus agrifolia*, in central coastal California, November. Found once in the San Francisco Bay area.

COLLECTION EXAMINED — U.S.A., California, Contra Costa Co., Tilden Regional Park, 16 November 2000, E.C. Vellinga 2484 (nrITS GU136182).

COMMENTS — This large conspicuous taxon was only found once. It differs from the other species in the pale colours and absence of strong reddening reactions.

9. *Lepiota flammeotincta* Kauffman, Papers Mich. Acad. Sci., Arts Letters 4: 331.

1924 (as '*Lepiota flammeatincta*').

FIGURES 15–18

SELECTED DESCRIPTION — Kauffman (1924: 331–332).

TYPE STUDY — Smith (1966: 103–105).

MICROSCOPICAL CHARACTERS (FROM VELLINGA TYPE STUDY; Figure 15) — BASIDIOSPORES [21,1,1] in side-view 7.4–9.3 × 4.4–5.0 µm, avl × avw = 7.9 × 4.7 µm, Q = 1.58–1.91, avQ = 1.7, oblong, some subamygdaliform, in frontal

view oblong and not amygdaliform, thick-walled, with central guttule, without germ pore, congophilous, swelling in ammonia and Congo Red, dextrinoid, metachromatic in Cresyl Blue. BASIDIA $21\text{--}30 \times 8.0\text{--}10 \mu\text{m}$, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $30\text{--}45 \times 5.0\text{--}9.0 \mu\text{m}$, cylindrical, very narrowly clavate, a few wavy, not coloured. PLEUROCYSTIDIA absent. PILEUS COVERING made up of adnate hyphae, with parietal brown-grey pigment in ammonia, with extracellular red granules, and some elements filled with very dark pigments in clumps; hyphae unified in squamose fibrils; terminal elements cylindrical with rounded apex, $36\text{--}119 \times 6.5\text{--}9.5 \mu\text{m}$. CLAMP CONNECTIONS not observed.

DESCRIPTION OF MODERN MATERIAL (FIGS 16–18) — PILEUS (7–)14–45 mm, convex, plano-convex to applanate with small and low umbo, at centre pale grey brown at first, turning to dark brown (7.5 YR 3/2), almost black felted-tomentose, around centre with radially arranged fibrillose v-shaped squamules, starting out very pale, but changing to dark brown with age, on white to pale background which immediately and vividly discolours orange-red on touching, after some time completely dark brown. LAMELLAE, L = 35–50, l = (0–)1–3, moderately distant to moderately crowded, free and close to stipe, rounded off near stipe, (sub)ventricose, up to 6 mm wide, white to cream with pinkish

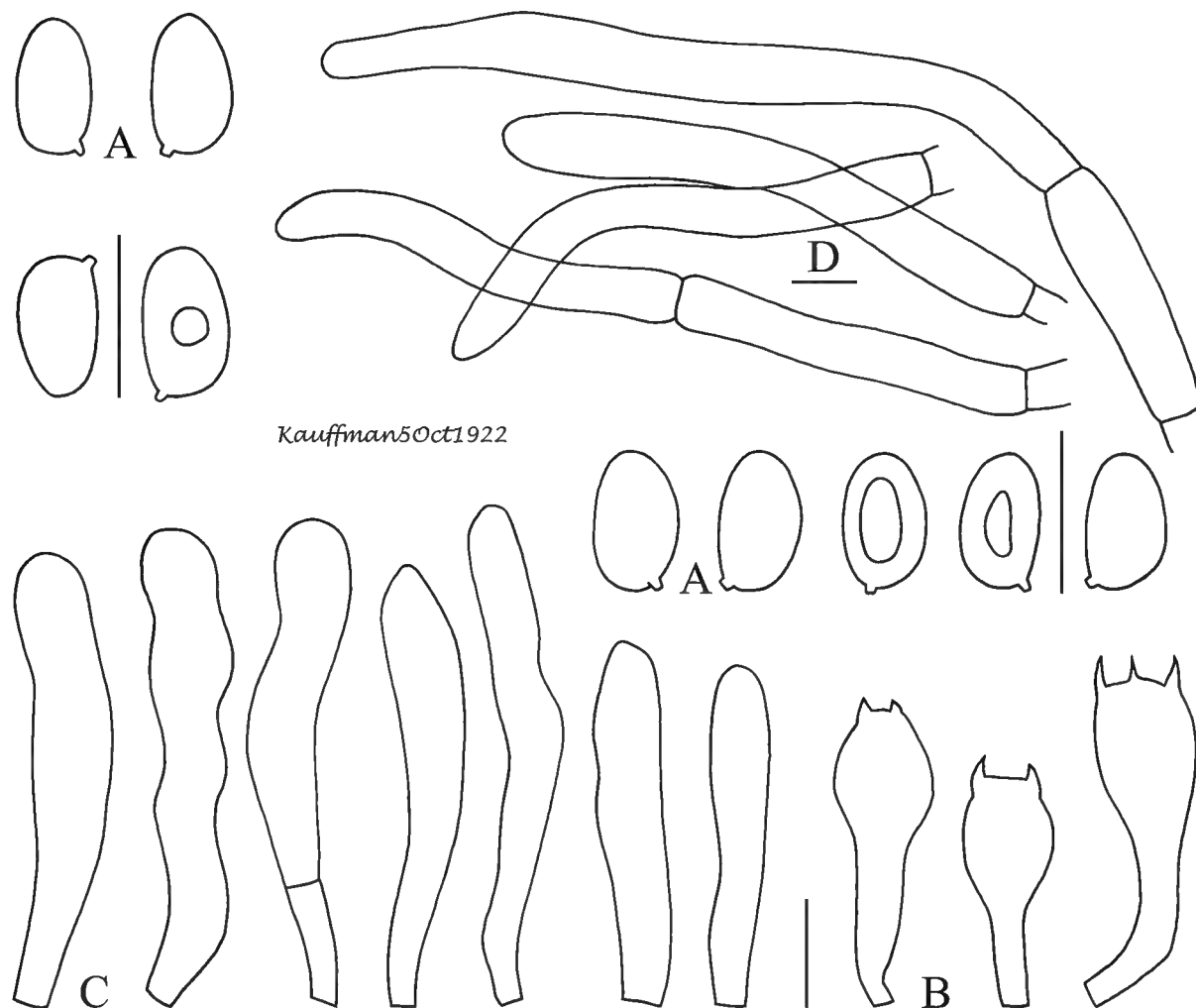


FIG. 15. *Lepiota flammeotincta* — A. spores; B. basidia; C. cheilocystidia; D. pileus covering elements (all from holotype collection). Scale bars $10 \mu\text{m}$.

sheen, not changing colours when cut or touched; lamella edge white cystidiose, with some very fine colourless drops when young, dark where touched. STIPE 40–80 × 2.5–4 mm, cylindrical, gradually widening towards 4–7 mm wide base, white at first, but instantly intensely red staining when touched, changing to dark brown fibrillose where touched, lengthwise short-fibrillose hollow, with some white rhizomorphs. ANNULUS often absent in mature specimens, flimsy, not with a distinct cuff and flaring part, dark on outside, and with a dark rim, white on the inside. CONTEXT whitish in pileus, dull rather thick, immediately orange-red when cut; in stipe white at first, shiny, with age pale brownish to glassy yellowish. SMELL rubber-like to astringent lepiotoid and unpleasant, sometimes with fruity component.

CHEMICAL TESTS — KOH 3% on lamellae reddish, on pileus red, on stipe hard to see reaction.

DRIED SPECIMENS with dark pileus and stipe, but lamellae pale and strongly contrasting with the rest of the basidiocarps.

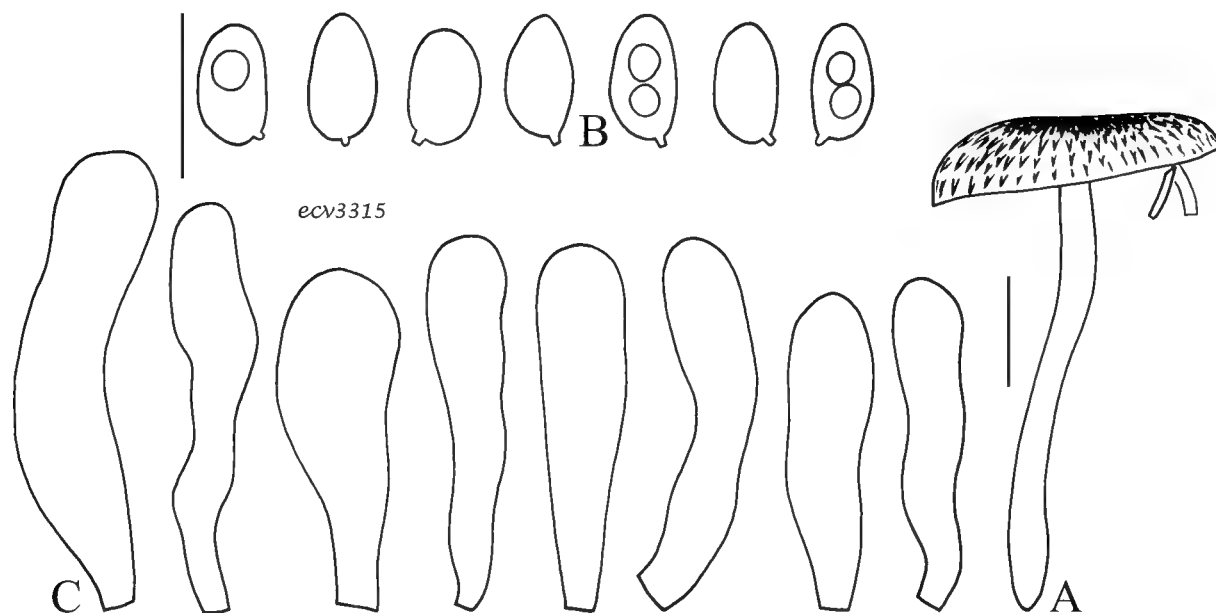


FIG. 16. *Lepiota flammeotincta* — A. basidiocarp; B. spores; C. cheilocystidia (from collection ecv3315). Scale bar 10 mm (A); microscopic features 10 μ m.

BASIDIOSPORES [146,8,8] in side view 5.9–9.0 × 3.4–5.6 μ m, $avl \times avw = 6.5\text{--}7.5 \times 3.9\text{--}4.5 \mu\text{m}$, $Q = 1.5\text{--}2.1$, $avQ = 1.65\text{--}1.85$, (the longer values for collections with a relatively high number of 2-spored basidia), oblong to almost cylindrical, with straight abaxial side, and convex adaxial side, some subamygdaliform, in frontal view oblong to almost cylindrical, thick-walled, smooth, without germ pore, and often uniguttulate, congophilous, dextrinoid, metachromatic in Cresyl blue, with walls swelling in ammonia. BASIDIA 16.5–32 × 6.5–9.0 μ m, 4-spored, but in some collections with a relatively high number with 2 sterigmata. LAMELLA EDGE sterile. CHEILOCYSTIDIA 25–70 × 4.5–12.0(–13.0) μ m, cylindrical, cylindrical-wavy (at least a few), more rarely narrowly clavate to narrowly utriform, with some dark brown granules or very pale brown in

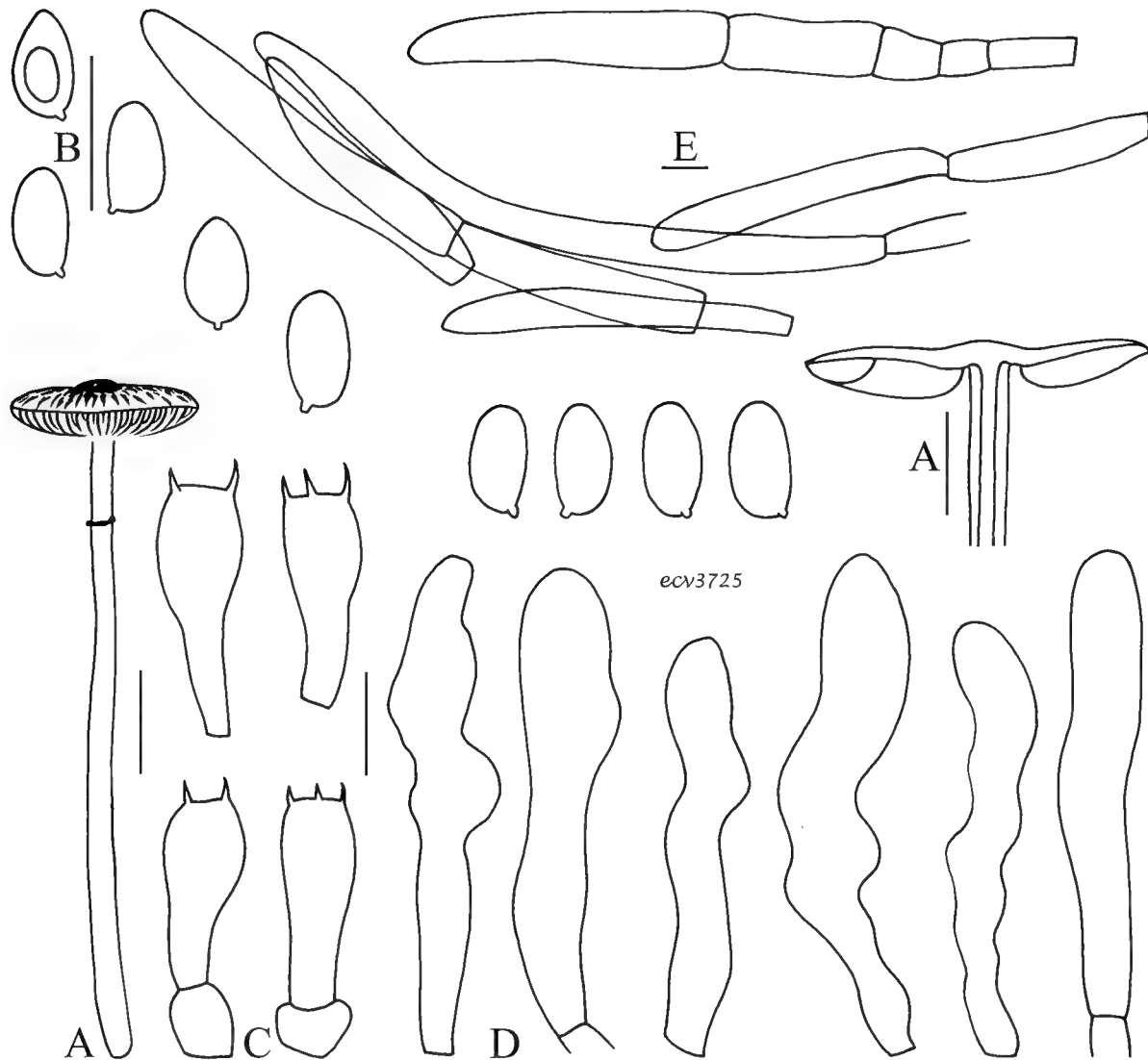


FIG. 17. *Lepiota flammeotincta* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from collection ecv3725).
Scale bar 10 mm (A); microscopic features 10 μ m.

ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING cutis-like with bundles of repent to ascending hyphae, made up of brown-walled, sometimes incrustated cells, also with dark granules and blobs and intracellular brown pigment (in ammonia); extracellular pigment blobs present; terminal elements, $55\text{--}180 \times 5\text{--}16 \mu\text{m}$, cylindrical to slightly inflated, not or differentiated with rounded or acuminate tips. CLAMP CONNECTIONS not observed.

HABITAT AND DISTRIBUTION – Solitary or gregarious in small groups, terrestrial and saprotrophic in litter, in different types of coniferous forests, e.g. in coastal pine forests, in coastal mixed forests and in the Sierra foothills, widespread and common, October through December. Also known from Oregon and Washington.

COLLECTIONS EXAMINED – U.S.A., California, Humboldt Co., Patrick's Point State Park, 9 November 2004, E.C. Vellinga 3250 (nrITS GU136168); near Orrick, along Davison Road, 10 November 2004, E.C. Vellinga 3266; ibidem, 27 October 2007, N.H. Nguyen 003 (nrITS GU136169); ibidem, 7 November 2009, E.C. Vellinga 4101; Marin Co., Tomales Bay State Park, 28 November 2001, E.C. Vellinga 2746 (nrITS AY176440)

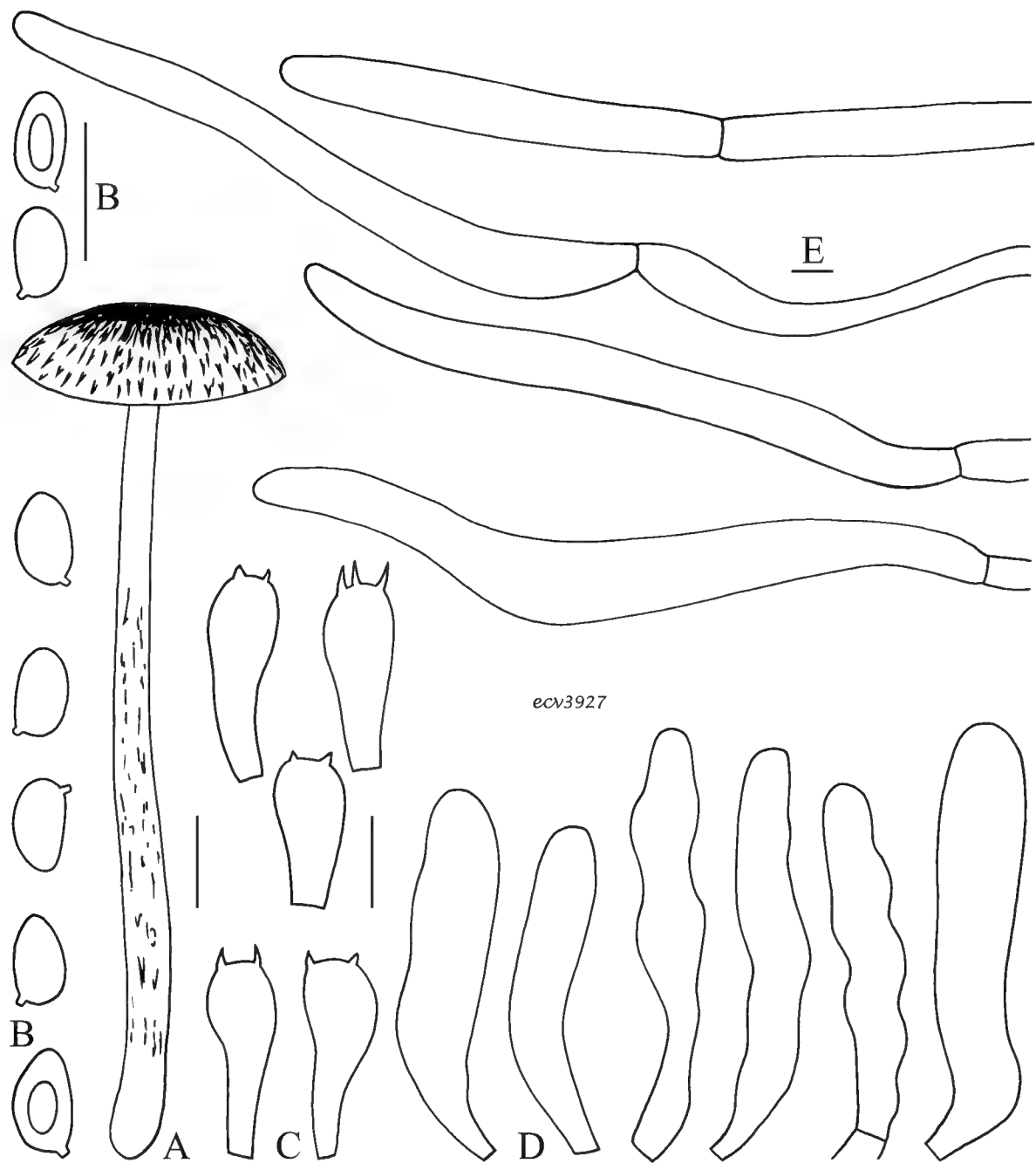


FIG. 18. *Lepiota flammeotincta* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from ecv3927). Scale bar 10 mm (A); microscopic features 10 μ m.

and 2757; ibidem, near Hearts Desire Beach, 22 November 2008, E.C. Vellinga 3927 (nrITS GU136163); Point Reyes NP, 6 October 2001, E.C. Vellinga 2644; Point Reyes NP along Sky Trail, 31 October 2009, S.P. Schechter (coll. E.C. Vellinga 4093); Mendocino Co., Jackson State Demonstration Forest, 18 November 2000, E.C. Vellinga 2533 (nrITS AY176441); ibidem, 17 November 2001, E.C. Vellinga 2704 and 2717; ibidem, 23 November 2002, E.C. Vellinga 2911, 2912 and 2913; ibidem, 20 November 2004, E.C. Vellinga 3295 (nrITS GU136166); Jughandle State Reserve, 19 November 2007, E.C. Vellinga 3725 (nrITS GU136170); Van Damme SP, 19 November 2000, E.C. Vellinga 2529. Nevada Co., San Juan Ridge, near North Columbia Schoolhouse on Tyler Foote Rd, 13 December 2003, E.C. Vellinga 3174; San Mateo Co., San Mateo County Memorial Park, 5 December 2008, F. Stevens et al. (coll. E.C. Vellinga 3967) (nrITS GU136167). Sonoma Co., Salt Point State Park, 22 November 2004, E.C. Vellinga 3315 (nrITS GU136165). Yuba Co., Challenge, along Oregon Rd, 10 November 2005, E.C. Vellinga

3359 (nrITS GU136171) and 3361 (nrITS GU136164). **Oregon**, Clackamas County, Mt Hood near Welches, 5 October 1922, C.H. Kauffman (Holotype, MICH).

COMMENTS — What was thought to represent just one species, *L. flammeotincta*, turned out to be a complex, with two common taxa, *L. flammeotincta*, and *La. flammeotinctoides* (described below), two rarely observed species, and one putative taxon based on a single collection.

The distinction between the two common and most intensely reddening species is microscopical, based on the shape of the cheilocystidia: cylindrical and often wavy-constricted to narrowly clavate in *L. flammeotincta*, and only narrowly clavate, with an occasional cylindrical one, in *La. flammeotinctoides*. The lamellae of the more robust *La. flammeotinctoides* stain reddish, and nrITS sequences distinguish the two species very convincingly.

The other satellite taxa have irregularly shaped, non-cylindrical cheilocystidia, and differ in subtle pileus covering characters or spore shape. *Lepiota flammeotincta* and *La. flammeotinctoides* ‘bleed’ heavily, the others less so. It is amazing, and frustrating, that species that differ so clearly in sequence data are hard to distinguish morphologically.

The strong reddening reaction of *L. flammeotincta* might be the reason that KOH on the surfaces did not have the chance to turn the tissues green.

Kauffman’s (1924) macroscopical description of *L. flammeotincta* is very accurate and complete, an excellent example of good and thorough observation without drowning in unnecessary details.

Smith (1966), who also studied the type collection, noted narrowly clavate cheilocystidia and slightly smaller spores than observed here. Only cylindrical and very narrowly clavate cheilocystidia, some wavy, were observed for this study.

Johnson (1999) included a collection from Costa Rica for which she used the name *L. flammeotincta*, but the nrITS, nrLSU, and mtSSU sequences (GenBank accession numbers U85331, U85296 and U85363 resp.) represent a different, unidentified species.

Unlike *La. erythrophaeus*, *L. fuliginescens*, and *La. adelphicus*, *L. flammeotincta* does not have a sister species in Europe. In fact, all European species of section *Piloselli*, except *L. roseolivida*, have a trichodermal pileus covering.

10. *Leucoagaricus flammeotinctoides* Vellinga, sp. nov.

FIGURES 19 & 20

MYCOBANK MB 515367

Lepiota flammeotinctae similis, lamellis post tactum discolorentibus, cheilocystidiis (tenuiter) clavatis, nucleari spatii interne transcripti (“nrITS”) ordine differt.

HOLOTYPE — “U.S.A., California, Mendocino County, Jughandle SR, 19 November 2007, E.C. Vellinga 3729 (UC),” (nrITS GU136173).

ETYMOLOGY: The epithet *flammeotinctoides* refers to the resemblance to *L. flammeotincta*; the word combines the Latin ‘*flammeotincta*’ with the suffix ‘-oides’ derived

from the Greek, resulting in a more euphonious word than the completely Latin and grammatically correct 'flammeotinctaster' with the same meaning.

PILEUS 31–60 mm, plano-convex, to applanate with central depression and (low, broad) umbo to wavy, at first dark grey at umbo, soon dark brown to dark red-brown (5 YR 3/3), plushy velvety-tomentose on umbo, around umbo with concentric rings of dark brown material as on pileus centre, and further towards margin with small fibrillose radially arranged dark brown scales to small cobwebby fibrils on white background, gradually lighter towards margin to pale brown (7.5 YR 8/2), on pale background and margin; fibrils red when touched, but background not changing colour; marginal zone sulcate in some specimens. **LAMELLAE**, $L = 50\text{--}60$, $l = 0\text{--}1$, crowded or moderately crowded, free and 1 mm remote from stipe, some furcate, segmentiform to ventricose, 4–6 mm wide, white-cream to yellowish white coloured, orange near margin, orange-red when touched, with white cystidiose-dentate edge, changing via orange to dark with pressure and age, but this reaction can be slow and weak. **STIPE** 70–135 \times 4–7 mm, slightly narrower at apex, 8–13 mm wide at base, protruding slightly into pileus, white, lengthwise innately fibrillose and hirsute all over, changing instantly to bright orange-red when bruised, turning dark brown with time, hollow. **ANNULUS** an ascending white cuff and a small flaring part with dark rim, with dark fibrils as on pileus, and turning completely dark. **CONTEXT** white to whitish and dull in pileus, but where cut (especially under umbo) red or orange but soon fading, shiny to glassy white to pale brownish with age in stipe, orange when cut (fresh specimens). **SMELL** none, indistinct or astringent lepiotoid to rubber-fungoid.

DRIED SPECIMENS dark with dark lamellae.

BASIDIOSPORES [140,8,8] in side view 5.9–8.8 \times 3.1–4.6 μm , $avl \times avw = 6.4\text{--}7.8 \times 3.5\text{--}4.1 \mu\text{m}$, $Q = 1.5\text{--}2.2$, $avQ = 1.74\text{--}1.88$, ellipsoid to subcylindrical, with rounded apex, a few subamygdaliform, in frontal view similar as in side-view, thick-walled and smooth, uniguttulate, congophilous, dextrinoid, metachromatic in Cresyl blue. **BASIDIA** 18–29 \times 6.5–9.5 μm , 4-spored. **LAMELLA EDGE** completely sterile, or with tufts and groups of cystidia. **CHEILOCYSTIDIA** 22–53(–75) \times 5.0–15.0 μm , clavate, narrowly clavate, narrowly utriform or sublageniform, occasionally cylindrical, a few with really long pedicel, with dark brown contents and big inclusions or granules in ammonia. **PLEUROCYSTIDIA** absent. **PILEUS COVERING** cutis-like made up of strands of mostly repent, more rarely ascending brown-walled hyphae; terminal elements 63–200(–260) \times 9.0–15.5 μm , cylindrical to slightly inflated, with rounded apex, or attenuated towards apex; penultimate elements often much shorter; pigment brown parietal and intracellular, exuding out of material in ammonia, with dark brown granules, and can be incrusting in all elements except terminal ones. **CLAMP CONNECTIONS** absent.

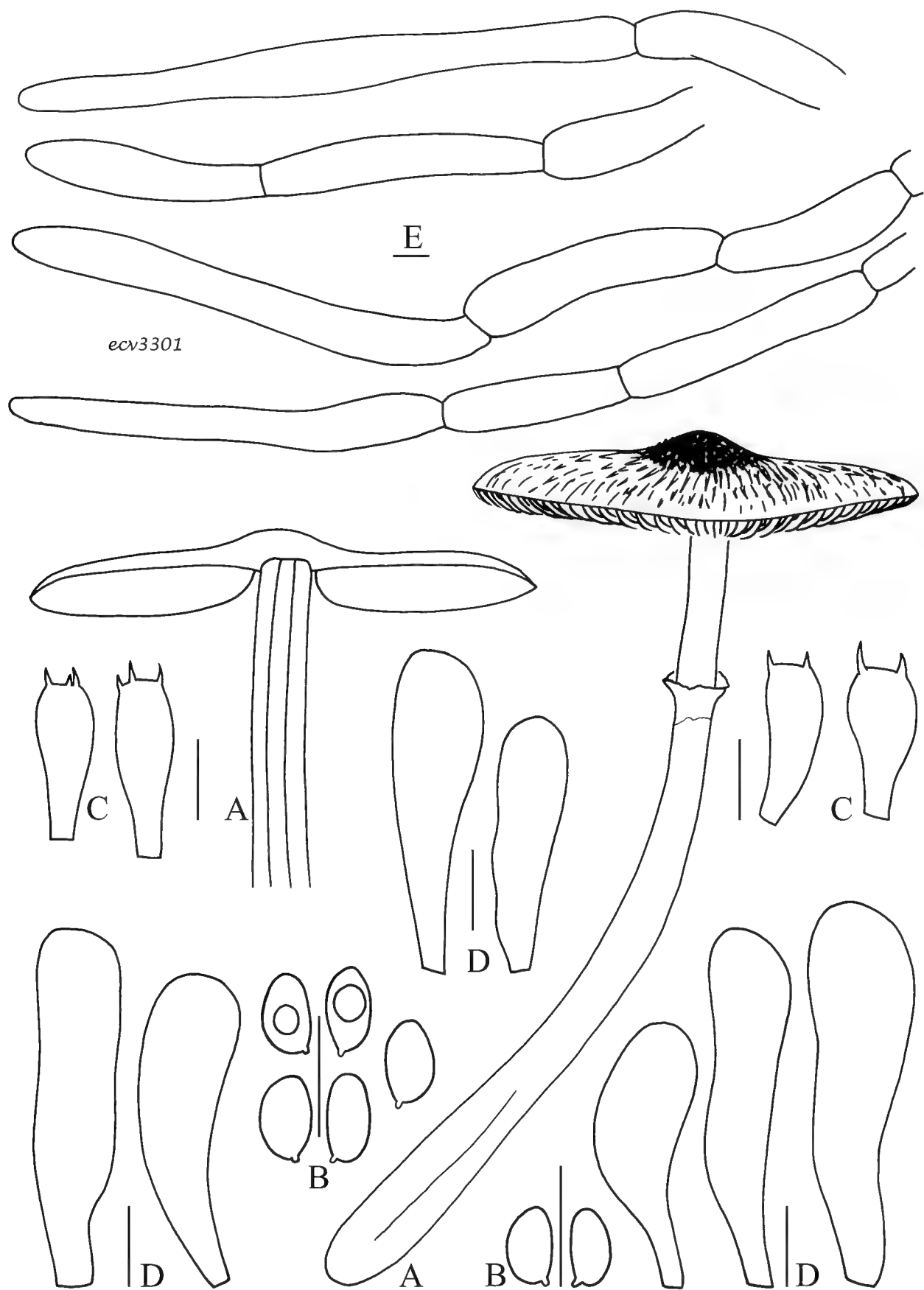


FIG. 19. *Leucoagaricus flammeotinctoides* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from ecv3301) .
Scale bar 10 mm (A); microscopic features 10 μ m.

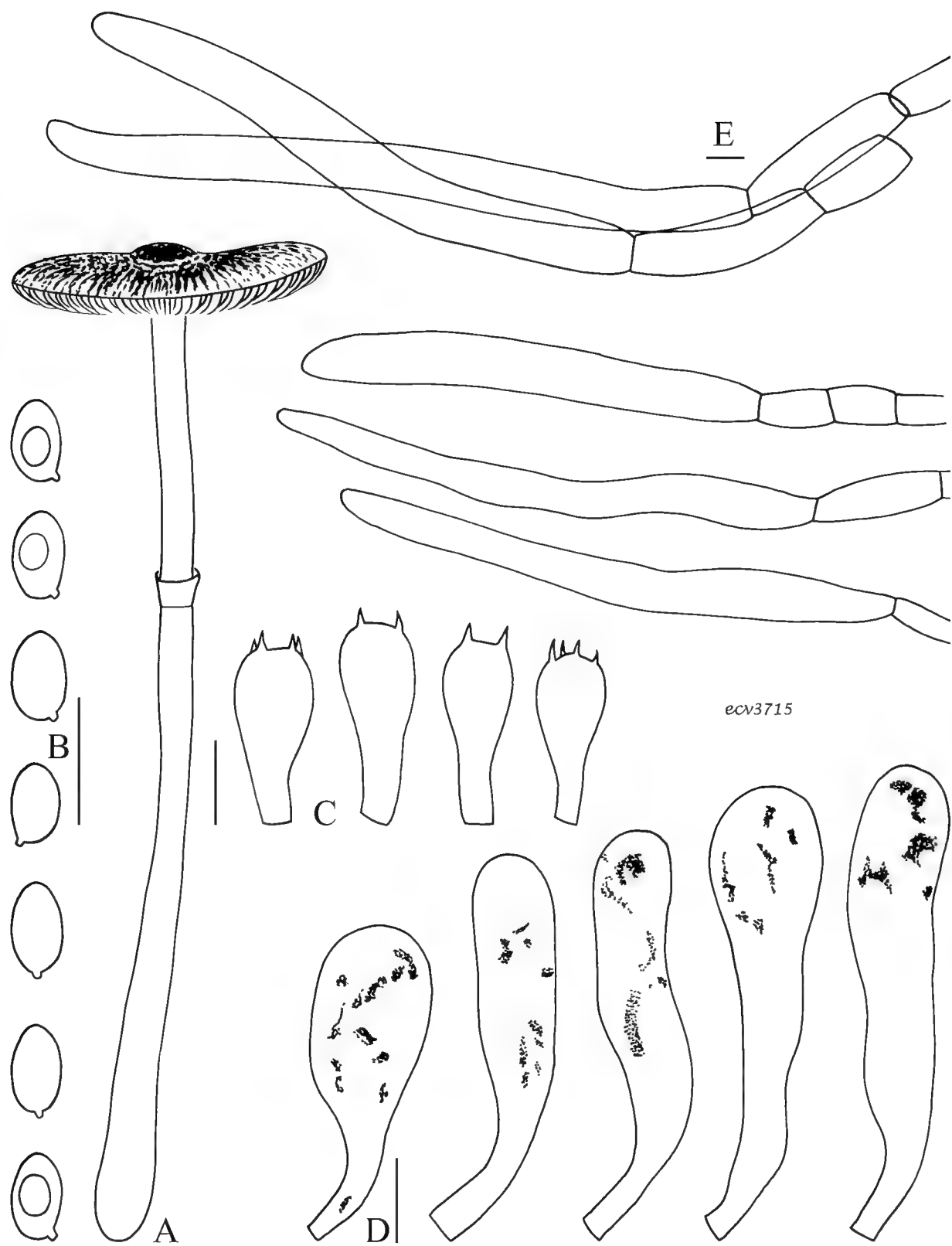


FIG. 20. *Leucoagaricus flammeotinctoides* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from 3715) .
Scale bar 10 mm (A); microscopic features 10 μ m.

HABITAT AND DISTRIBUTION – Solitary to gregarious in small groups, terrestrial and saprotrophic, in coastal mixed coniferous forests, with or without *Sequoia sempervirens*, in northern California, November and early December.

ADDITIONAL COLLECTIONS EXAMINED — U.S.A., **California**, Humboldt Co., Patrick's Point SP, 9 November 2004, E.C. Vellinga 3247 (nrITS GU136174); Marin Co., Samuel P. Taylor State Park, 28 November 2001, E.C. Vellinga 2759 (nrITS AY243620); Mendocino County, Jackson State Demonstration Forest, 20 November 2004, E.C. Vellinga 3301 (nrITS GU136175), 3304 (nrITS GQ258475) and 3308 (nrITS GQ258476); Van Damme SP, along Fern Canyon Trail, 18 November 2007, E.C. Vellinga 3715 (nrITS GU136172); San Mateo Co., San Mateo County Memorial Park, 5 December 2008, F.A. Stevens et al. (collection ecv3966) (nrITS GU136176).

COMMENTS — *Leucoagaricus flammeotinctoides* resembles *L. flammeotincta* in the rapid staining reaction of pileus and stipe, but it differs in the bigger and more robust basidiocarps, the staining lamellae, and the narrowly clavate cheilocystidia. The lamellae are more remote from the stipe than in *L. flammeotincta*. Wavy cylindrical cheilocystidia, so characteristic for *L. flammeotincta*, have never been observed in this species.

It seems to be less common than *L. flammeotincta* s. str., not yet found outside the coastal forests, but its real distribution and occurrence are unknown.

The new species could be confused with *La. erythrophaeus* because of the staining lamellae, but that species has a pseudocollarium to which the lamellae are attached and a trichodermal pileus covering structure.

11. *Leucoagaricus pyrrhophaeus* Vellinga, sp. nov.

FIGURE 21

MYCOBANK MB 515369

A Lepiota flammeotincta cheilocystidiis clavatis ad lageniformibus vel irregularibus differt.

HOLOTYPE — “U.S.A., California, Humboldt County, near Orick, along Davidson's Road, 10 November 2004, E.C. Vellinga 3268 (UC),” (nrITS GU136199).

ETYMOLOGY: derived from the Greek words πυρρος, ‘red, flame-coloured, yellowish-red’, and φαιος, ‘dark’; chosen because of the reaction of the tissues when exposed to air.

PILEUS 25–30 mm plano-convex with low umbo, dark red-brown (2.5 YR 2.5/3) at umbo, around umbo with concentric and towards margin more radially oriented tufts of fibrils, v-shaped, concolorous with umbo, on white background which easily discolours orange; margin irregularly fringed, exceeding lamellae. **LAMELLAE**, L = around 50, l = 0, 1 or 3, moderately crowded, free and remote from stipe, ventricose, whitish with cystidioid edge glistening with some colourless drops; edge discolouring when touched to orange changing to dark brown-black. **STIPE** 50–70 × 2.5–3 mm, gradually widening downwards to 6 mm wide base, pale pinkish at apex, below annulus with dark fibrils where touched, turning orange, then dark, when scratched, cystidioid-fibrillose above annulus, hollow. **ANNULUS** not very elaborate, not a distinct cuff but funnel-shaped, with a broadened rim, pale on the inside, with dark upper rim, and some dark fibrils on outside.

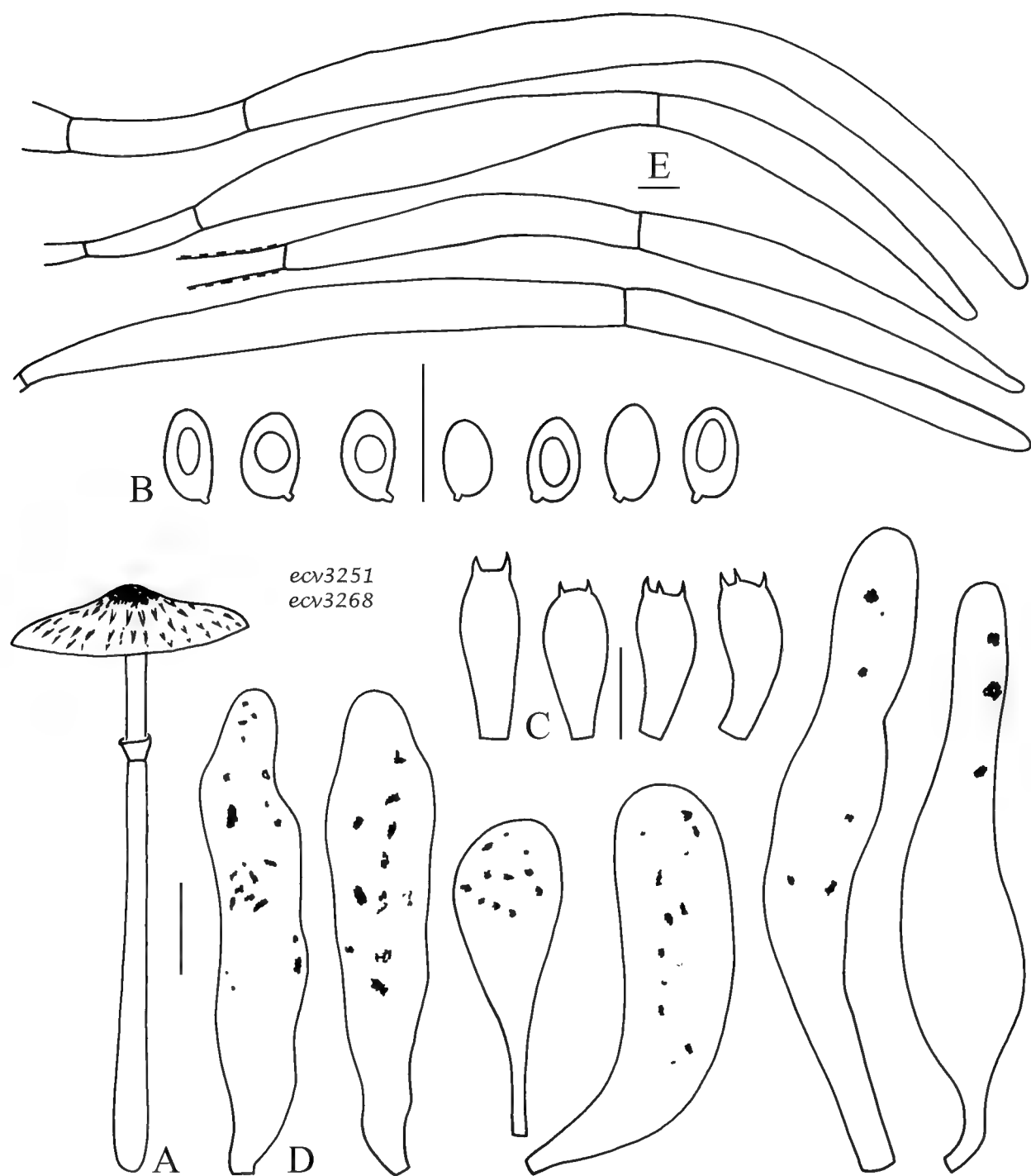


FIG. 21. *Leucoagaricus pyrrhophaeus* — A. Basidiocarp (holotype, collection ecv3268); B. spores; C. basidia; D. cheilocystidia; E. pileus covering elements (all microscopic features from collection ecv3251). Scale bar 10 mm (A); microscopic features 10 μ m.

DRIED SPECIMENS copper coloured, with coloured lamellae.

BASIDIOSPORES [35,2,2] in side view $5.5\text{--}7.2 \times 3.4\text{--}4.2 \mu\text{m}$, $\text{avl} \times \text{avw} = 6.4\text{--}6.6 \times 3.8 \mu\text{m}$, $Q = 1.4\text{--}2.0$, $\text{av}Q = 1.68\text{--}1.75$, oblong, with flattened abaxial side, with rounded, non-amygdaliform apex, smooth and thick-walled, with guttule, without germ pore, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA $13\text{--}18 \times 6.0\text{--}8.0 \mu\text{m}$, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $30\text{--}68 \times 9.0\text{--}13 \mu\text{m}$, irregularly lageniform to utriform, some clavate, some

narrowly lageniform, with brown contents and dark granules in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING with repent to upright brown-walled hyphae with brown contents and some dark granules in ammonia, some with incrusting pigments; most typically 3 coloured elements in a row, with the terminal element the biggest, and slightly differentiated, narrowing into acute apex, in most cases elements not widened at the septa; with lowest elements the narrowest or narrowing at base; terminal elements $115\text{--}285 \times 12\text{--}20 \mu\text{m}$; penultimate elements up to $25 \mu\text{m}$ wide. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION – Solitary or in small groups, terrestrial in coastal coniferous forests of northern California, under *Picea sitchensis*, or in a mixed conifer forest with *Sequoia sempervirens*, *Picea sitchensis* and *Tsuga heterophylla*. So far only found in Humboldt County. November.

ADDITIONAL COLLECTION EXAMINED – U.S.A.: California, Humboldt Co., Patrick's Point State Park, 9 November 2004, E.C. Vellinga 3251 (nrITS GQ258473).

COMMENTS — *Leucoagaricus pyrrhophaeus* belongs to the group of species that look very much like *L. flammeotincta*. In particular, it resembles *Leucoagaricus* sp. (collection ecv3723), but differs in the hyphae of the pileus covering with non-inflated elements, resulting in smooth hyphae; *La. pyrrhulus* also comes close but has amygdaliform spores. All three have cheilocystidia that show a certain resemblance to Dr. Seuss creatures. *Leucoagaricus pyrrhophaeus* stains less easily red when touched than *L. flammeotincta* and *La. flammeotinctoides*; furthermore, the cheilocystidial shape also easily separates it from both these species. Thus far, nrITS sequences differentiate these taxa more easily than morphological characters.

12. *Leucoagaricus pyrrhulus* Vellinga, sp. nov.

FIGURE 22

MYCOBANK MB 515368

A Lepiota flammeotincta in pileo fibrillis tenuibus, sporis amygdaliformibus, cheilocystidiis clavatis ad lageniformibus differt.

HOLOTYPE — “U.S.A., California, Mendocino County, Jackson Demonstration State Forest, 20 November 2004, E.C. Vellinga 3306 (UC)”, (nrITS GQ258474);

ETYMOLOGY: *pyrrhulus* is derived from the Greek word πυρρος, ‘red, flame-coloured, yellowish-red’. Some linguistic freedom has been applied to coin the diminutive, referring to the small fibrils on the pileus surface in comparison to the other species in the complex.

PILEUS 15–30 mm, plano-convex to applanate without distinct umbo, dark brown at centre, white around centre with very small dark brown cobwebby fibrils and a dark margin from pressure (after bringing home), with some dark radial streaks from touching, with glistening surface, immediately orange when scratched. LAMELLAE, L = around 30, l = 0 or 1, moderately crowded, free but not remote from stipe, ventricose, cream with distinctly white cystidioid edge.

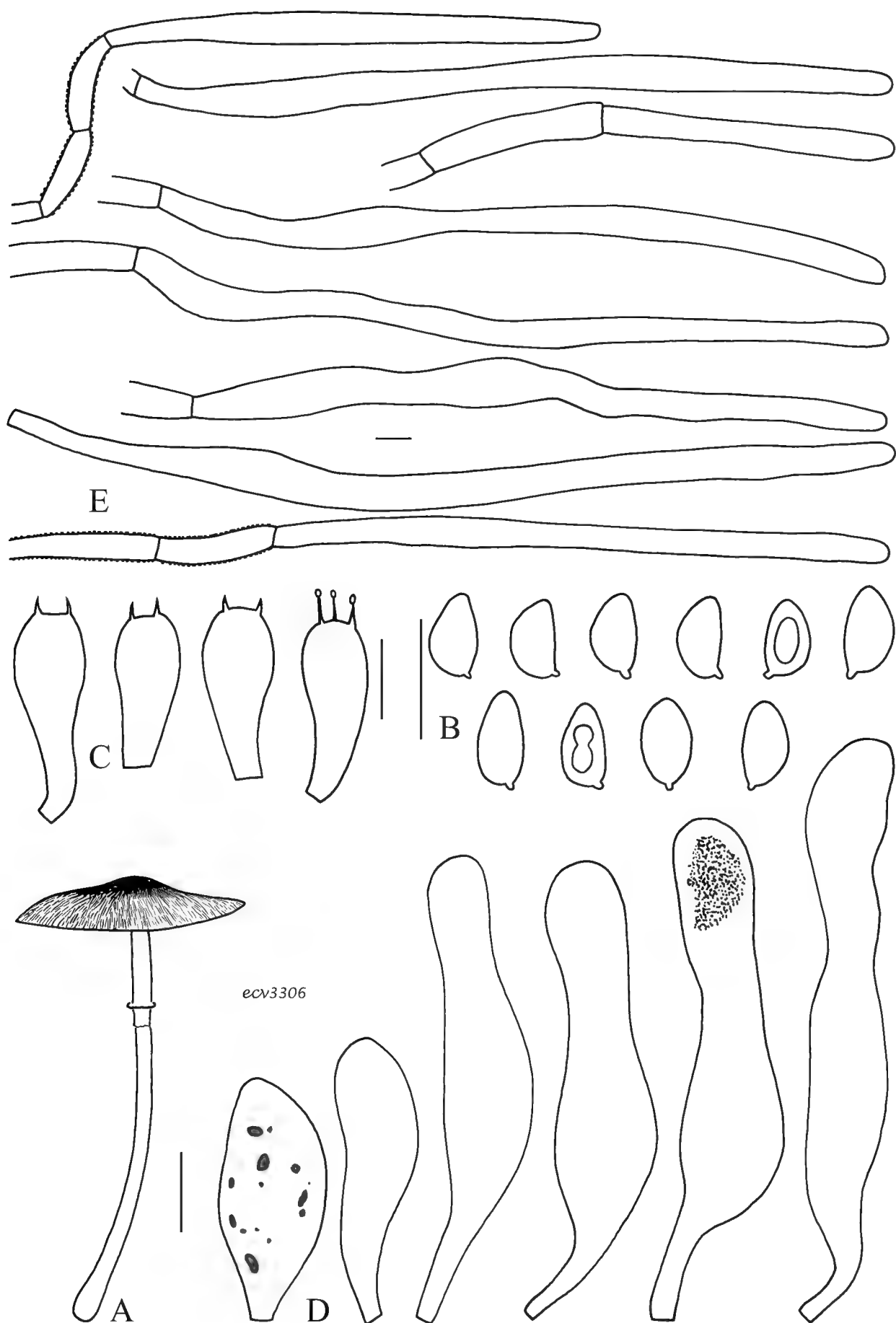


FIG. 22. *Leucoagaricus pyrrhulus* — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering (all from holotype, collection ecv3306).
Scale bar 10 mm (A); microscopic features 10 μ m.

STIPE 30–50 × 1.5–2.5 mm, cylindrical or slightly widened at base, whitish all over, but dark where touched, hairy cystidiose all over, hollow. ANNULUS small, with a small ascending cuff, and a small dark flaring part. SMELL indistinct.

DRIED SPECIMENS with pink to dark lamellae.

BASIDIOSPORES [20,2,2] in side-view 6.1–7.8 × 3.2–4.4 µm, $av_l \times av_w = 6.8\text{--}6.9 \times 3.7\text{--}4.0$ µm, $Q = 1.6\text{--}2.1$, $avQ = 1.7\text{--}1.83$, amygdaliform-oblong or oblong with rounded apex, in frontal view oblong-obovoid, smooth, thick-walled, with one or more guttules, congophilous, dextrinoid, metachromatic in Cresyl blue. BASIDIA 21–26 × 7.0–8.5 µm, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA 43–67 × 7.0–14 µm, lageniform with long neck, some with subcapitate apex or with moniliform neck, a few clavate, with green-brown contents and dark granules or concretions in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING a cutis made up of dark reddish brown hyphae in bundles on top of a yellow-brown lower layer with thin hyphae, some of which have finely incrusting pigment. Hyphae of upper layer with long cylindrical to slightly differentiated terminal elements, 80–250 × 9–13 µm, with rounded, non attenuated tips, with parietal pigment. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION — Solitary, terrestrial in mixed coniferous forests with *Sequoia sempervirens*, in coastal northern California, found twice near Mendocino, November.

ADDITIONAL COLLECTION EXAMINED — U.S.A., California, Mendocino Co., Van Damme SP, Fern Canyon, 18 November 2007, E.C. Vellinga 3719 (nrITS GU136201).

COMMENTS — *Leucoagaricus pyrrhulus* is close in general appearance to the other species in the *L. flammeotincta* group, but it has finer fibrils on pileus, does not strongly discolour when touched, and is the only species with amygdaliform spores. It also differs in the shape and size of the cystidia from both *L. flammeotincta* and *La. flammeotinctoides* but the shape of the cheilocystidia is similar to those found in *La. pyrrhophaeus*.

Differences with the undescribed taxon, *Leucoagaricus* sp. (collection ecv3723), are subtle, but again, the amygdaliform spores distinguish *La. pyrrhulus*, and nrITS sequence data clearly separate them. More material is needed to assess the morphological diversity of and the distinctions among these taxa.

13. *Leucoagaricus* sp. (collection ecv3723)

FIGURE 23

PILEUS 31 mm, wide-conical with umbo, deep dark brown and tomentose at umbo, around umbo with short, small dark radial fibrils on whitish background, not arranged into v-shaped squamules or cobwebby, but individually arranged; background whitish to dirty pale orange where touched. LAMELLAE, L = around 45, l = 0 or 1, free, but not remote from stipe, moderately spaced, not distant,

nor crowded, subventricose, whitish with pinkish sheen, with white cystidiose edge, changing to yellow when pestered. STIPE 75 × 3 mm, gradually widening downwards to 6 mm, cream coloured when fresh, when picked immediately orange-red, changing to dirty and dark brown, hairy-tomentose, but in lower half with dark fibrils, hollow. ANNULUS an ascending cuff and a small flaring part which is dark brown and distinctly hairy-tomentose at underside. CONTEXT very thin in pileus, white, red at centre from cutting through the umbo, in stipe concolorous with surface. SMELL like the sweet and rubber components of the smell of *L. cristata*.

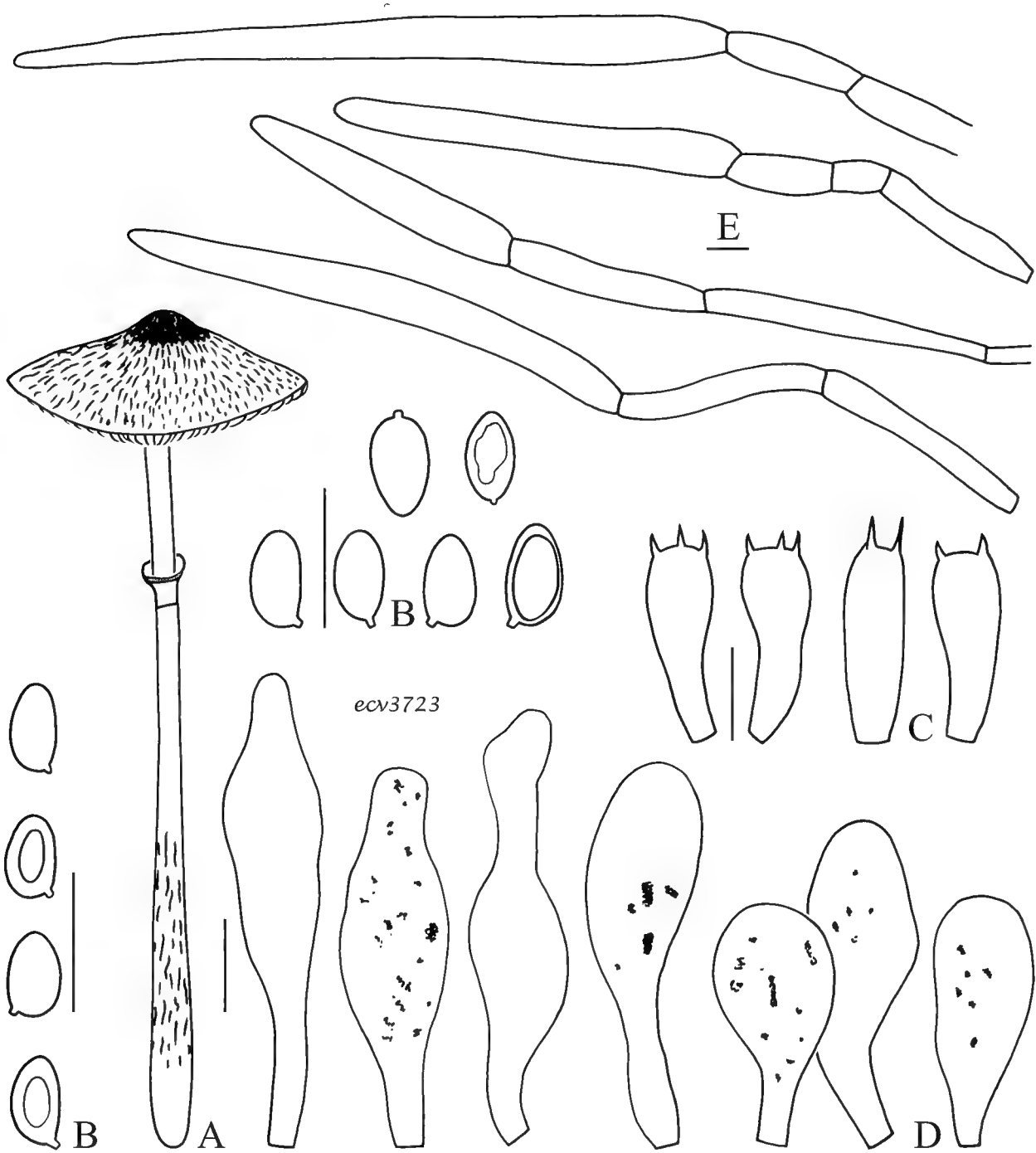


FIG. 23. *Leucoagaricus* sp. (collection ecv3723) — A. Basidiocarp; B. spores; C. basidia; D. cheilocystidia; E. elements of pileus covering. Scale bar 10 mm (A); microscopic features 10 µm.

DRIED SPECIMENS with red-copper tinges and pinkish lamellae.

BASIDIOSPORES [20,1,1] in side view $5.7\text{--}7.1 \times 3.4\text{--}4.0 \mu\text{m}$, $\text{avl} \times \text{avw} = 6.1 \times 3.7 \mu\text{m}$, $Q = 1.55\text{--}1.85$, $\text{av}Q = 1.66$, ellipsoid to oblong with slightly straighter adaxial than abaxial side, with rounded apex, a few subamygdaliform, in frontal view ellipsoid to oblong, with guttule, thick-walled, smooth, without germ pore, congophilous, dextrinoid, metachromatic in cresyl blue. BASIDIA $19\text{--}21 \times 6.0\text{--}7.5 \mu\text{m}$, 4-spored. LAMELLA EDGE sterile. CHEILOCYSTIDIA $20\text{--}48 \times 9.0\text{--}13 \mu\text{m}$, variable, clavate, more or less lageniform to utriform and relatively long, with brown contents and dark granules in ammonia. PLEUROCYSTIDIA absent. PILEUS COVERING around centre with repent red-brown-walled hyphae made up of 3–5 coloured elements; terminal elements slightly differentiated and inflated, longer than the penultimate cells, $100\text{--}250 \times 15\text{--}18 \mu\text{m}$. CLAMP CONNECTIONS absent.

HABITAT AND DISTRIBUTION – Solitary, terrestrial, in mixed forest, with *Picea sitchensis*, *Pinus muricata* D. Don, and *Sequoia sempervirens*, only found once, in Mendocino County, November.

COLLECTION EXAMINED – U.S.A., California, Mendocino Co., Jughandle State Natural Reserve, 19 November 2007, E.C. Vellinga 3723 (nrITS GU136200).

COMMENTS — More material is needed to assess whether this is a species in its own right. This collection is closely related to *La. pyrrhophaeus*, with which it shares the copper colours of the dried specimens. The shape of the pileus covering elements differs slightly in *La. pyrrhophaeus* as the cells in that species do not show inflations at the septa. The differences with the other taxa in the *L. flammeotincta* group are subtle, and pertain to the shape of the spores and cheilocystidia, and colour changes of the basidiocarps.

Key to the California species in the *Leucoagaricus* /*Leucocoprinus* clade that turn red on bruising

1. Pileus covering lilac or raspberry pink to lilac, fibrillose or plushy tomentose all over
2. Pileus lilac to pink, fibrillose; basidiocarp slender; pileus covering with repent hyphae; spores amygdaliform *L. roseolivida*
[not uncommon in California, description in Vellinga (2007a)]
2. Pileus raspberry pink; basidiocarp sturdy, with pileus width equal to stipe length; pileus covering with upright elements; spores with rounded apex *L. decorata*
[rare, only known from a few collections in California and Oregon, fruiting relatively late in the season; description in Vellinga (2007a)]
1. Pileus covering starting out very pale, changing to dark brown to black, or predominantly with dark brown to black, brown, grey or brick red colours; background can turn deep raspberry pink with age

3. Basidiocarps staining brick red with age and with ammonia, but not turning green with ammonia; spores with distinct apical papilla. *L. castanescens*
[not uncommon in California, common further north, e.g. in Washington;
description in Vellinga & Sundberg (2008)]
3. Basidiocarps staining green with ammonia (in strongly reddening species this reaction might be obscured); spores without apical papilla
4. Spores with a germ pore
 5. Pileus (70–)100–230 mm with brown squamules; spores with distinct germ pore; elements of pileus covering tapering towards narrow apex; basidiocarps solitary or in small clusters *La. americanus*
[occasionally fruiting in the western states of North America, on wood chips or probably on hidden roots etc., widespread in North American and Europe; type description in Vellinga (2000); description of European material in Reid (1990), and Vellinga (2001)]
 5. Pileus 13–50(–80) mm with small, dot-like dark brown squamules (starting out pale grey-brown); spores with indistinct germ pore; elements of pileus covering with blunt apex; basidiocarps in big clusters *La. meleagris*
[occasionally fruiting in the western states of North America, on wood chips etc., widespread and known from eastern North America, Hawaii, Europe and Asia; description of European material in Reid (1990), and Vellinga (2001)]
4. Spores without a germ pore
 6. Pileus covering made up of repent hyphae, with or without differentiated terminal elements *L. flammeotincta* group (5 taxa)
 7. Cheilocystidia (at least some) cylindrical and wavy (best seen when lamella edge is severely squashed), most cylindrical to narrowly clavate; lamellae not staining red when damaged 9. *L. flammeotincta* s. str.
 7. Cheilocystidia not wavy at all; lamellae often staining red when damaged
 8. Cheilocystidia clavate, narrowly clavate 10. *La. flammeotinctoides*
 8. Cheilocystidia variable, from clavate to irregularly utriform, or lageniform
 9. Spores amygdaliform; pileus with fine fibrils 12. *La. pyrrhulus*
 9. Spores with rounded, non-amygdaliform apex; pileus with v-shaped squamules
 10. Pileus covering elements not constricted at septa 11. *La. pyrrhophaeus*
 10. Pileus covering elements slightly inflated and constricted at septa 13. *Leucoagaricus* sp. (collection ecv3723)
 6. Pileus covering trichodermal made up of upright elongated, rarely cystidioid, elements

12. Cheilocystidia clavate with terminal, often moniliform, excrescence; basidiocarps starting out rather pale and often developing pink-purple tinges
13. Basidiocarps medium to large (pileus > 35 mm; stipe 60–125 × 5–16 mm, up to 20 mm at base); pileus covering made up of elongated elements only 1. *L. fuliginescens*
13. Basidiocarps small to medium (pileus < 35 mm; stipe 13–40 × 1.5–3 mm); pileus covering made up of cystidioid and clavate elements *La. georginae*
[known from the state of Washington and from Europe; included in the analysis of nrITS sequences of FIG. 1; description of European collections in Vellinga (2001)]
12. Cheilocystidia lacking long terminal excrescence, clavate, narrowly clavate or broadly clavate, fusiform to lageniform, cylindrical, or narrowly utriform
14. Lamellae staining when damaged
 15. Lamellae attached to a collarium-like structure; cheilocystidia clavate, up to 90 µm long 6. *La. erythrophaeus*
 15. Lamellae not attached to a collarium-like structure; cheilocystidia if clavate, shorter
 16. Basidiocarps sturdy, fleshy (pileus 30–120 mm); pileus with pink-brown tomentose covering, changing to evenly dark brown with age 2. *La. cupresseus*
 16. Basidiocarps medium to small (pileus 30–60 mm); pileus warm red-brown or with dark centre and patches on light background
 17. Pileus warm red-brown all over; cheilocystidia varied, narrowly clavate, clavate, fusiform-utriform to clavate with terminal excrescence 4. *La. hesperius*
 17. Pileus white with very dark centre and a radiating pattern of dark patches on an off-white background; cheilocystidia cylindrical 7. *La. pardalotus*
14. Lamellae not staining red when damaged (although lamella edge might discolour)
 18. Pileus dark red-brown, fibrillose around centre; cheilocystidia long (50–75 µm long), narrowly clavate 8. *Leuocagaricus* sp. (collection ecv2484)
 18. Pileus red-brown, warm red-brown, plush-like velvety-tomentose; cheilocystidia clavate, narrowly clavate (up to 55 µm long)
 19. Pileus covering with long elements; cheilocystidia clavate 3. *La. adelphicus*
 19. Pileus covering with bundles of short elements; cheilocystidia narrowly clavate 5. *La. dyscritus*

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Literature cited

- Arora D. 1986. Mushrooms demystified. A comprehensive guide to the fleshy fungi. Ed. 2. Ten Speed Press, Berkeley. 959 pp.
- Aulinger K, Arnold N, Steglich W. 2000. Metabolites of 2-aminophenol from fruit bodies of *Lepiota americana* (Agaricales). Zeitschrift für Naturforschung Section C Journal of Biosciences 55 (5–6): 481–484.
- Boisselet P. 2002 ('2001'). *Leucoagaricus marginatus* comb. nov., espèce d'origine californienne retrouvée en France. Bulletin trimestriel de la Société mycologique de France 117: 183–192.
- Boisselet P, Guinberteau J. 2001. *Leucoagaricus cupresseus* (Burlingham) Boisselet & Guinberteau comb. nov., une lépiote cupressicole d'origine américaine récoltée en France. Bulletin de la Fédération des Associations mycologiques méditerranéennes, n.s. 19: 33–42.
- Bon M. 1993. Flore mycologique d'Europe 3. Les Lépiotes. *Lepiotaceae* Roze. Documents mycologiques. Mémoire hors série 3: 1–153.
- Burlingham GS. 1945. Noteworthy species of *Lepiota* and *Lactaria*. Mycologia 37: 53–64.
- Candusso M, Lanzoni G. 1990. *Lepiota* s.l. Fungi europaei 4. Giovanna Biella, Saronno. 743 pp, 80 pl.
- Demoulin V. 1966. Le problème de *Lepiota badhamii* et de *Lepiota rufovelutina*. Lejeunia 39: 1–15.
- Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. Molecular Ecology 2: 113–118.
- Gennari A, Migliozi V. 1999 ('1998'). Una nuova entità della sezione *Piloselli*, *Leucoagaricus aurantiovergens* sp. nov. Rivista di Micologia 41: 291–300.
- Guinberteau J, Callac P, Boisselet P. 1998. Inventaire des communautés fongiques liées au *Cupressus macrocarpa* en zone littorale atlantique et données récentes sur les populations sauvages d'*Agaricus bisporus*. Bulletin trimestriel de la Société mycologique de France 114(2): 19–38. 1998.
- Heinemann P. 1973. Leucocoprinées nouvelles d'Afrique centrale. Bulletin du Jardin botanique national de Belgique 43: 7–13.
- Holmgren PK, Holmgren NH. 1998 [continuously updated]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. <http://sweetgum.nybg.org/ih/> [accessed June 2009].

- Johnson J. 1999. Phylogenetic relationships within *Lepiota* sensu lato based on morphological and molecular data. *Mycologia* 91: 443–458.
- Katoh K, Misawa K, Kuma K, Miyata T. 2002. MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. *Nucleic Acids Research* 30: 3059–3066.
- Kauffman CH. 1924. The genus *Lepiota* in the United States. *Papers from the Michigan Academy of Science, Arts and Letters* 4: 319–344.
- Kühner R. 1936. Recherches sur le genre *Lepiota*. *Bulletin trimestriel de la Société mycologique de France* 52: 177–238.
- Locquin M. 1945. Notes sur les Lépiotes II. *Bulletin mensuel de la Société linnéenne de Lyon* 14: 44–52, 53–63, 82–88, 89–100.
- Migliozi V, Perrone L. 1992. Sulle Lepiotee - 8° contributo. Descrizione di *Leucoagaricus brunnescens* (Peck) Bon e creazione della sottosezione *Pilatiani* Migliozi et Perrone. *Bollettino dell'associazione micologica ed ecologica romana* 26: 3–9.
- Migliozi V, Resta G. 2001. Note sulla sottosezione *Pilatiani* del genere *Leucoagaricus*, due nuove varietà: *Leucoagaricus pseudopilatianus* var. *rugosoreticulatus* e *Leucoagaricus pseudopilatianus* var. *roseodiffractus*. *Micologia e vegetazione mediterranea* 15: 129–156.
- Migliozi V, Rocabrana A, Tabarés M. 2001. *Leucoagaricus pseudopilatianus*: una nueva especie de la sección *Piloselli*. *Revista Catalana de Micologia* 23: 67–74.
- Munsell™ soil color charts. 1975. Baltimore.
- Murrill WA. 1912. The *Agaricaceae* of the Pacific Coast II. *Mycologia* 4: 231–262.
- Murrill WA. 1914. *Agaricaceae* (pars). *North American Flora* 10(1): 1–79.
- Peck CH. 1896. New species of fungi. *Bulletin of the Torrey botanical Club* 23: 411–420.
- Peck CH. 1904. New species of fungi. *Bulletin of the Torrey botanical Club* 31: 177–182.
- Pegler DN. 1986. Agaric flora of Sri Lanka. *Kew Bulletin additional Series* 12: 1–519.
- Reid DA. 1990. The *Leucocoprinus badhamii* complex in Europe: species which redden on bruising or become green in ammonia fumes. *Mycological Research* 94: 641–670.
- Singer R. 1973. Diagnoses fungorum novorum *Agaricalium* III. *Beihefte Sydowia* 7: 1–106.
- Smith AH, Hesler LR. 1938. Notes on Agarics from Tennessee and North Carolina. *Journal of the Elisha Mitchell Scientific Society* 54: 261–268 + 2 plates.
- Smith HV. 1966. Contributions toward a monograph on the genus *Lepiota*, I. Type studies in the genus *Lepiota*. *Mycopathologia et mycologia applicata* 29: 97–117.
- Smith HV, Weber NS. 1987. Observations on *Lepiota americana* and some related species. *Contributions from the University of Michigan Herbarium* 16: 211–221.
- Stamatakis A, Hoover P, Rougemont J. 2008. A rapid bootstrap algorithm for the RAxML web-Servers. *Systematic Biology* 75: 758–771.
- Sundberg WJ. 1967. The family *Lepiotaceae* in California. Master's thesis, San Francisco State University. 219 pp.
- Sundberg WJ. 1976. *Lepiota* sensu lato in California. II. Type studies of *Lepiota cupressea* and *Lepiota marginata*. *Mycotaxon* 3: 381–386.
- Sundberg WJ. 1995. A type study of *Lepiota pulverapella*. *Documents mycologiques* 25(98–100): 449–451.
- Swofford DL. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.
- Vellinga EC. 2000. Notes on *Lepiota* and *Leucoagaricus*. Type studies on *Lepiota magnispora*, *Lepiota barssii*, and *Agaricus americanus*. *Mycotaxon* 76: 429–438.
- Vellinga EC. 2001. *Leucoagaricus*. Pp. 85–108, in ME Noordeloos, ThW Kuyper, EC Vellinga (eds). *Flora agaricina neerlandica* 5. A.A. Balkema Publishers, Lisse/Abingdon/ Exton(PA)/Tokyo.

- Vellinga EC. 2004a. Genera in the family *Agaricaceae* — Evidence from nrITS and nrLSU sequences. *Mycological Research* 108: 354–377.
- Vellinga EC. 2004b. Ecology and distribution of lepiotaceous fungi (*Agaricaceae*). *Nova Hedwigia* 78: 273–299.
- Vellinga EC. 2007a. Lepiotaceous fungi in California, U.S.A. — 3. Pink and lilac species in *Leucoagaricus* sect. *Piloselli*. *Mycotaxon* 98: 213–224.
- Vellinga EC. 2007b. Lepiotaceous fungi in California, U.S.A. — 5. *Lepiota oculata* and its look-alikes. *Mycotaxon* 102: 267–280.
- Vellinga EC, Noordeloos ME. 2001. Glossary. Pp. 6–11, in ME Noordeloos, ThW Kuyper, EC Vellinga (eds). *Flora agaricina neerlandica* 5. A.A. Balkema Publishers, Lisse/Abingdon/Exton (PA)/Tokyo.
- Vellinga EC, Sundberg WJ. 2008. Lepiotaceous fungi in California, U.S.A. 6. — *Lepiota castanescens*. *Mycotaxon* 103: 97–108.
- Vellinga EC, Contu M, Vizzini A. 2010. *Leucoagaricus decipiens* and *La. erythrophaeus*, a new species pair in sect. *Piloselli*. *Mycologia* 110: 447–454, doi:10.3852/09-164.
- Wood M, Stevens F. 1996-2008. The fungi of California. www.mykoweb.com/CAF/ [accessed Aug. 2009]
- Zeller SM. 1933. New or noteworthy agarics from Oregon. *Mycologia* 25: 376–391.

Four lichens of the genus *Lecidea* from China

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Abstract — Two species (*Lecidea berengeriana*, *L. confluens*) and one variety (*L. lapicida* var. *pantherina*) new to China and an unknown species of *Lecidea* are reported. Photos of the thalli are presented.

Key words — *Lecideaceae*, Asia, taxonomy

Introduction

The genus *Lecidea* (*Lecideaceae*) was established by Acharius (1803). Its originally extremely wide circumscription became reduced step by step. Zahlbruckner used *Lecidea* in an extraordinary wide circumscription, accepting more than 1350 taxa in the rank of species. Subsequently, many obviously unnatural units have been excluded (e.g. *Adelolecia*, *Amygdalaria*, *Biatora*, *Carbonea*, *Claurouxia*, *Clauzadea*, *Melanolecia*, *Micarea*, *Miriquidica*, *Nesolechia*, *Porpidia*, *Psilolechia*, *Psora*, *Pyrrhospora*, *Rimularia*, *Schaereria*, *Tephromela*, *Trapelia*, *Trapeliopsis*, *Tylothallia*). *Lecidea* s. str. became a medium-sized (about 100 species), almost exclusively saxicolous genus (Hertel 1995), based on the structure of the ascomata, especially the nature of the hamathecial tissues, ascus apical structures, and exciple (Purvis et al. 1992, Hertel 1995). Hertel (1967, 1977, 1995) based his narrow concept of *Lecidea* s. str. on the type species, *Lecidea fuscoatra* (L.) Ach. However, there are still many taxa included in *Lecidea* that obviously do not belong in *Lecidea* s. str. (Hertel 2004).

Worldwide, *Lecidea* s. lat. includes about 400 known taxa. In China, 31 *Lecidea* s. lat. species have been reported (Wei 1991; Abass & Wu 1998; Aptroot 2002, 2003; Guo 2005). During our study of lichen flora of western China, one unknown species, two species, and a variety of *Lecidea* s. lat. new to China were found.

Materials and methods

The specimens examined are preserved in SDNU (Lichen Section of Botanical Herbarium, Shandong Normal University) or HMAS-L (Lichen Section, Herbarium of Mycology, Institute of Microbiology, Academia Sinica).

Thalli were examined and measured under dissecting microscope (COIC XTL7045B2). Characteristics of the apothecia were investigated by microscope (OLYMPUS CX21). Photos of the thalli were taken under OLYMPUS SZX12 with DP70. The chemical constituents were identified using thin layer chromatography (TLC) (Culberson 1972).

The new records

1. *Lecidea berengeriana* (A. Massal.) Nyl., Not. Sällsk. Fauna Fl. Fenn.

Förh. 8: 144 (1866)

FIG. 1A

= *Biatora berengeriana* A. Massal., Ric. Auton. Lich. Crost.: 128 (1852)

Thallus grayish to greenish-gray, verrucose, surface dull, esorediate; medulla I–. Apothecia sessile with a constricted base, 0.5–1.2 mm wide, flat and marginate when young but soon convex and immarginate, dark brown or blackish; exciple and hypothecium dark reddish brown, but outer edge of exciple colourless, giving the appearance of a thalline exciple; epithecium yellowish brown; hymenium 55–75 µm high, hyaline to pale yellowish, I+ blue, then turn red; hypothecium above dark reddish brown, below usually paler. Paraphyses 1.5–3 µm wide, becoming clavate to capitate and brown-walled at apices and to 6 µm wide, mostly simple. Asci *Porpidia*-type, 8-spored. Ascospores: hyaline, simple, fusiform-ellipsoid, 7.5–12.5 × 3–5 µm.

SPOT TESTS: thallus K–, C–, KC–, P–

SECONDARY METABOLITES: none

SPECIMENS EXAMINED: CHINA. Gansu, Tulugou, National forest park, on moss, alt. 2800 m, 19 Aug. 2007, J.G. Liu, 20072126 (SDNU); Qinghai, Qilian country, Mt. Niuxinshan, on moss, alt. 3200 m, 11 Aug. 2007, Z.S. Sun, LQ350(SDNU).

COMMENTS — *L. berengeriana* does not belong to the genus *Lecidea* s. str., but because its generic position is still unclear, it is retained in *Lecidea*. It is close to *L. hypnorum* and *L. sanguineoatra* but distinguished by its tartareous thallus and much broader, brown-walled apices of the paraphyses.

L. berengeriana has been reported from circumpolar in boreal regions of the Northern Hemisphere (Hertel & Printzen 2004). New to China.

2. *Lecidea confluens* (Weber) Ach., Meth. Lich.: 14 (1803)

FIG. 1B

Thallus well developed, whitish gray, irregularly rimose-areolate. Medulla I+ blue. Apothecia black, 0.5–1.1 mm wide, immersed to ± sessile, arising between

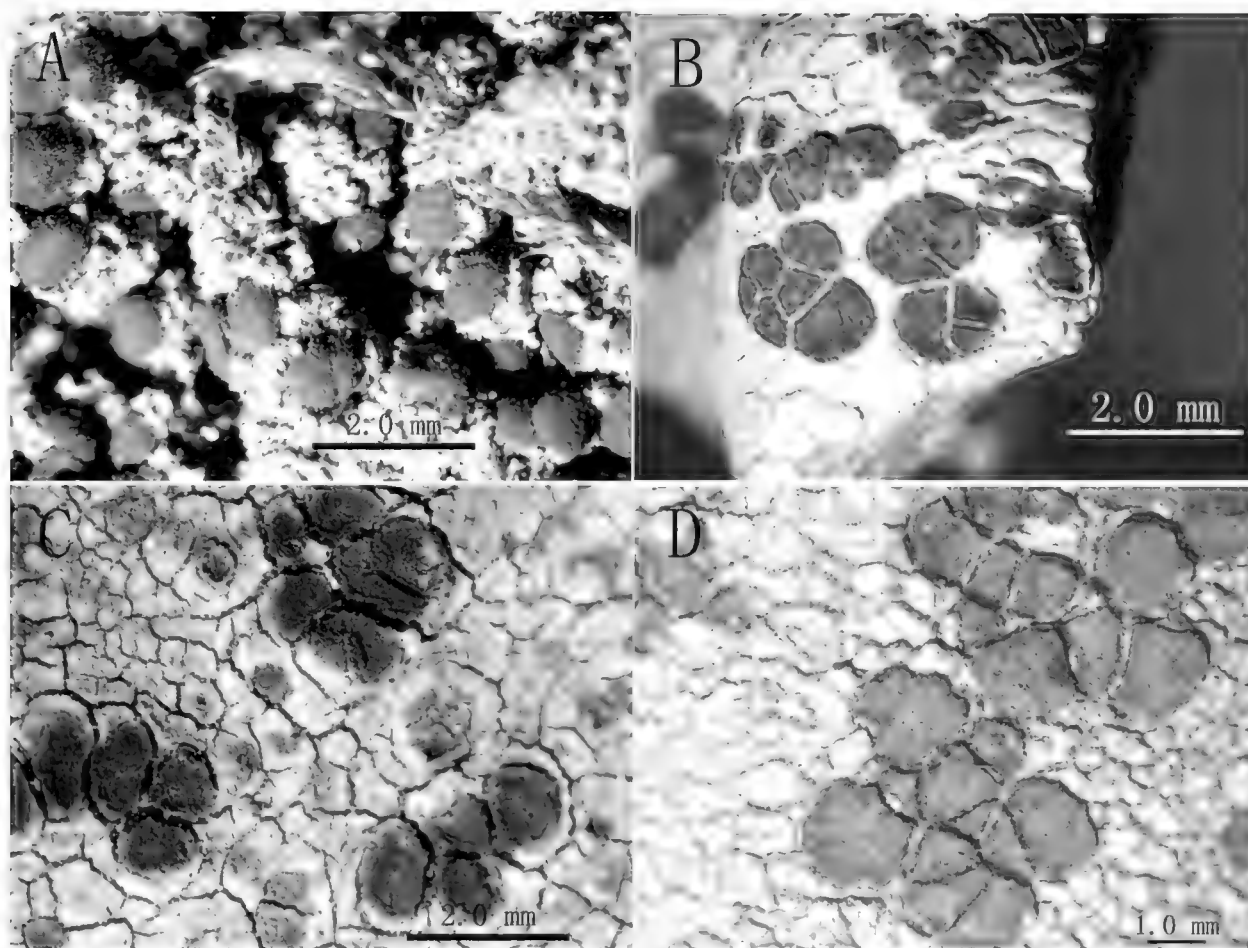


FIG. 1 Thalli of *Lecidea* species examined in the present study. A. *Lecidea berengeriana*, J.G Liu 20072126 (SDNU). B. *Lecidea confluens*, Z.T. Zhao 20071834 (SDNU). C. *Lecidea lapicida* var. *pantherina*, X.Y. Wang 025318 (HMAS-L). D. *Lecidea* sp. 1, J.G Liu 20071571-1 (SDNU).

the areoles; disc plane to slightly concave, epruinose, margin prominent; exciple blackish at out edge, colourless within; epithecium blackish green, hymenium colourless, 50–60 μm high; hypothecium dark brown. Asci *Lecidea*-type, 8-spored. Ascospores: hyaline, simple, ellipsoid, 8–10 \times 3.5–5 μm .

SPOT TESTS: K–, C–, KC–, P–

SECONDARY METABOLITES: confluent acid

SPECIMEN EXAMINED: CHINA. Qinghai, Xiangride country, Mt. Tuotushan, on rock, alt. 3080 m, 15 Aug. 2007, Z.T. Zhao, 20071834 (SDNU).

COMMENTS — *L. confluens* is morphologically close to *L. lapicida* and *L. tessellata*, but *L. confluens* has wider areoles, brown to dark brown hypothecium and smaller ascospores than *L. lapicida*, besides *L. lapicida* producing stictic or norstictic acid. *L. tessellata* has an almost colourless hypothecium and a bit smaller, blunter and more thick-walled ascospores. *L. confluens* has been reported from Eurasia, North America, and India (Upreti et al. 2006). New to China.

3. *Lecidea lapicida* var. *pantherina* (Hoffm.) Ach., Kongl. Vetensk. Akad. Nya Handl. 29: 232 (1808) FIG. 1C
 = *Lecidea lactea* Flörke ex Schaer., Lich. Helv. Spicil. 3: 127 (1828)

Thallus bluish-gray with yellow shade, medium, irregularly cracked-areolate, areolate plane; medulla I+ intensively violet-blue. Hypothallus ± distinct, black. Apothecia black, subimmersed to immersed to the thallus, not constricted at the base, or rarely somewhat constricted, 0.6–1.5 mm wide; margin rather thick and entire; disc plane. Exciple concolorous to the epithecium externally, colorless or pale brown internally; epithecium blackish-green; hymenium 40–60 µm high, I+ blue; subhymenium colorless; hypothecium with various heights, yellowish brown to blackish-brown. Paraphyses simple. Asci *Lecidea*-type, 8-spored. Ascospores: hyaline, simple, ellipsoid, 10–14 × 5–7 µm.

SPOT TESTS: Thallus K+ yellow, then red, KC+ yellow, C–, P+ yellow, medulla K–, C–, KC–, P–

SECONDARY METABOLITES: norstictic acid

SPECIMEN EXAMINED: CHINA. Sichuan, Xiaojin country, Mt. Balangshan, on rock, alt. 4300 m, 18 Aug. 1982, X.Y. Wang, 025318 (HMAS-L).

COMMENTS —It is morphologically similar to *L. lapicida* but differs in the predominance of norstictic acid.

L. lapicida var. *pantherina* has been reported from Asia (Hertel 1977, Inoue 1982) Europe, and North America. Its southern hemisphere distribution is mapped by Hertel (1997). New to China.

4. *Lecidea* sp. 1 FIG. 1D

Thallus crustose, whitish gray to gray, developed well, esorediate, irregularly areolate. Areoles contiguous, flat to slightly convex, 0.2–0.9 mm in diam; cortex, 20–35 µm; medulla white, I+ deeply blue. Hypothallus distinct, black-blue.

Apothecia black, sitting in between the areoles, usually not overtopping the areoles, 0.5–1.2 mm wide, singular or in sometimes large and dense groups (then outline of apothecia angular). Margin thin; disc flat to slightly convex, dull, weakly pruinose. Epihymenium green-black, 12.5–20 µm; hymenium hyaline, 50–62.5 µm high; subhymenium hyaline to light yellow 30–70 µm thick; hypothecium pale brown. Paraphyses simple not branched. Asci *Lecidea*-type, clavate, 40–50 × 15–18 µm, 8-spored. Ascospores hyaline, simple, wall thick, ellipsoid to broadly ellipsoid, 6.2–10 × 3.5–5 µm.

SPOT TESTS: cortex and medulla K–, C–, KC–, P–

SECONDARY METABOLITES (chemotype C): confluent acid, unknown (Rf class 5, blue-white in UV fluorescence after charring)

SUBSTRATE: on wood.

HABITAT: in arid climate. 38.2°N, 100.22°E

SPECIMEN EXAMINED: CHINA. Qinghai, Qilian country, Mt. Niuxinshan, on dead wood, alt. 3200 m, 11 Aug. 2007, J.G. Liu, 20071571-1 (SDNU)

COMMENTS — This species is characterized by its moderately thallus with a I+ deeply blue medulla, its distinct hypothallus, its pale brown hypothecium, and its small, thick-walled ascospores. This species is very close to *L. tessellata* but it has distinct blue-black hypothallus, an unknown secondary metabolite besides confluent acid, and its cortex is a palisade plectenchyma. Besides, this species grows on wood while *L. tessellata* grows on rock.

Acknowledgements

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Literature cited

- Abdulla A, Wu JN. 1998. Lichens of Xinjiang. Sci-Tech & Hygiene Publishing House of Xinjiang (K), Urumqi.
- Acharius. 1803. Methodus qua omnes detectos Lichenes 1 & 2. LV+393pp. Stockholm.
- Aptroot A. 2002. Corticolous and saxicolous lichens from Xishuangbanna, southern Yunnan, China. <http://www.nhm.uio.no/botanisk/lav/Yunnan>.
- Aptroot A, Sparrius LB. 2003. New microlichens from Taiwan. Fungal Diversity 14: 1-50.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. Journal of Chromatography 72: 113-125.
- Guo SY. 2005. Lichens. Fungi of northwestern China pp.31-82. Mycotaxon LTD. Ithaca, New York.
- Hafellner J. 1989. Die europäischen *Mxcobilimbia*-Arten – eine erste Übersicht (lichenisierte *Ascomycetes*, *Lecanorales*). Herzogia 8: 53-59.
- Hertel H. 1977. Gesteinsbewohnende Arten der Sammelgattung *Lecidea* (*Lichenes*) aus Zentral-, Ost- und Südasien. Khumbu Himal, Ergebnisse des Forschungsunternehmens Nepal-Himalaya, 6: 145-378.
- Hertel H. 1991. *Lecidea* in der Arktis III (*Lecideoide Flechten*, *Lecanorales*). Mitteilungen der Botanischen Staatssammlung München 30: 297-333.
- Hertel H. 1995. Schlüssel der Arten der Flechtenfamilie *Lecideaceae* in Europa. Bibliotheca Lichenologica 58: 137-180.
- Hertel H. 1997. On the genus *Lecidea* (*Lecanorales*) in southern Chile and Argentina. In: Tibell L., Hedberg I. (eds.): Lichen studies dedicated to Rolf Santesson. Symbolae Botanicae Upsalienses, Acta Universitatis Upsaliensis, Uppsala. 95-111.
- Hertel, H., Andreev M. P. 2003. On some saxicolous lecideoid lichens of the Beringian Region and adjacent areas of Eastern Siberia and the Russian Far East. Bryologist 106: 539-551.
- Hertel H., Printzen C. 2004. *Lecidea*. Pp. 287-309, in: Nash TH III, Ryan BD, Diederich P, Gries C, Bungartz F (eds.): Lichen flora of the greater Sonoran desert region, Vol.2. Lichens Unlimited, Arizona State University, Tempe, Arizona.

- Inoue M. 1982. The genera *Lecidea*, *Lecidella* and *Huilia* in Japan. Journal of science of the Hiroshima University, Series B, Div.2, 18:1-22.
- Purvis OW, Coppins BJ, Hawksworth DL, James PW, Moore DM. 1992. The lichen flora of Great Britain and Ireland. Natural History Museum Publications in association with The British Lichen Society, pp, 319-336.
- Upreti DK, Nayaka S, Andreev MP. 2006. Notes on some species of the lichen genus *Lecidea* from India. Mycotaxon 95: 323-330.
- Wei JC. 1991. An Enumeration of Lichens in China. International Academic Publishers, Beijing. 278 pp.

A new anamorphic rust fungus with a new record of *Uredinales* from Azad Kashmir, Pakistan

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Abstract — *Milesia kashmiriana* on *Athyrium dentigerum* is described as a new species, with *Puccinia coronata* var. *himalensis* as a new record for Pakistan.

Key words — *Hyalopsora*, Muchal, Neelum Valley, Sharda

Introduction

Azad Kashmir is a floristically rich area from which only about 23 species of rust fungi have been reported (Ahmad et al. 1997). In order to explore this floristically rich area, extensive surveys were carried out. During such surveys of the rust flora of Azad Kashmir, Pakistan, one member of Pteridophytes, *Athyrium dentigerum*, was found infected with a new anamorphic rust fungus *Milesia kashmiriana* belonging to *Pucciniastraceae*. Another rust, *Puccinia coronata* var. *himalensis*, is the first member of the *Uredinales* ever reported on *Piptatherum vicarium*.

Materials and methods

Freehand sections of infected tissue and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with a JSM5910 scanning electron microscope. Drawings of spores and paraphyses were made using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spore dimensions were taken using an ocular micrometer. At least 25 spores were measured for each spore stage. The rusted specimens have been deposited in the herbarium of the Botany Department, at the University of the Punjab, Lahore (LAH).

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Enumeration of taxa

Milesia kashmiriana Afshan, S.H. Iqbal, Khalid & Niazi, sp. nov. (Figs. A–D)

MYCOBANK MB 516713

Telia ignota. *Uredinia* amphigena, subepidermalia, flavido vel aurantio- flavidae. *Urediniosporae*, ovoideae, ellipsoideae vel pyriformae, dilute flavido vel aurantio- flavidae, 11–17 × 21–37 µm; poris germinationis 1–4, aequatorialibus; membrana 0.9–2 µm crassa, pariete levi vel echinulato; pedicellis hyalinis, 2–3 × 8–24 µm.

HOLOTYPE: On *Athyrium dentigerum* (Clarke) Mehra & Bir, Pakistan, Azad Jammu & Kashmir, Neelum valley, Muchal, at 3000 m a.s.l., 03 November, 2006. NSA # 786. (LAH Herbarium No. NSA 1020).

ETYMOLOGY: Named after the locality, Azad Jammu & Kashmir.

TELIA not observed. **UREDINIA** amphigenous, golden to yellow or yellowish orange, erumpent, powdery, covered by the epidermis or soon naked, scattered or irregularly grouped, rounded, 0.06–0.09 × 0.3–0.4 mm. **UREDINIOSPORES** ovoid to ellipsoid or nearly cylindrical to pyriform, light yellow to yellowish orange, sometimes with yellowish orange granules, 11–17 × 21–37 µm; germ pores 1–4, equatorial, capitate; wall 0.9–2 µm thick, smooth or finely echinulate; pedicel hyaline, minute, thin, 2–3 × 8–24 µm. **PARAPHYSES** absent.

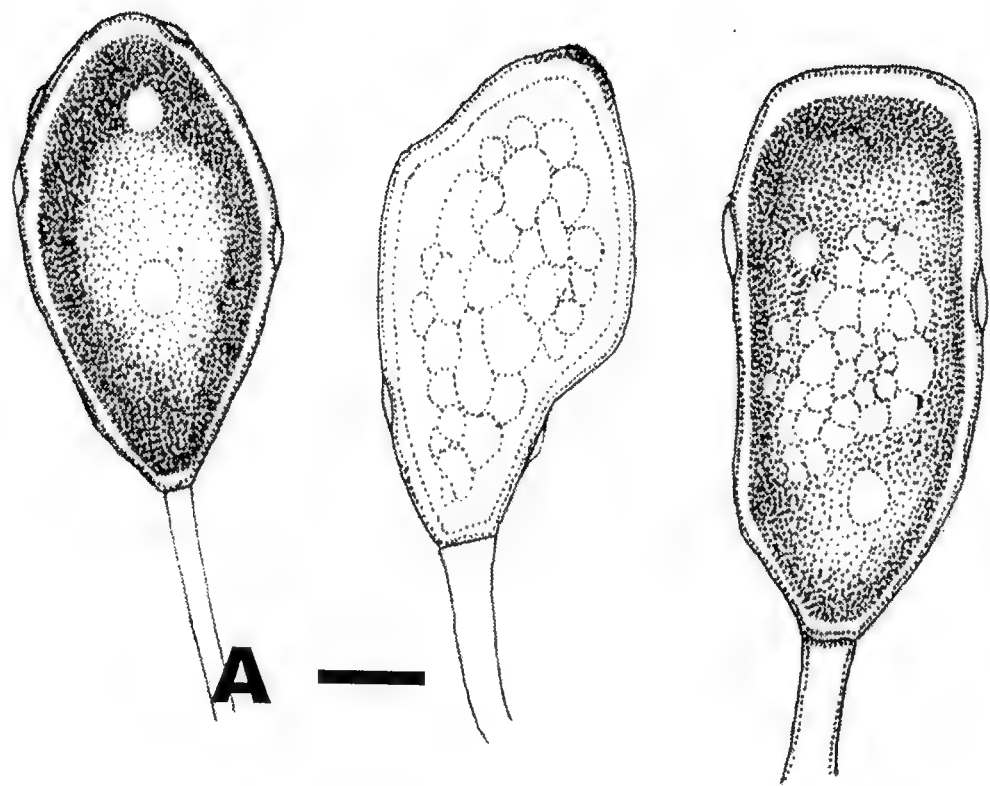
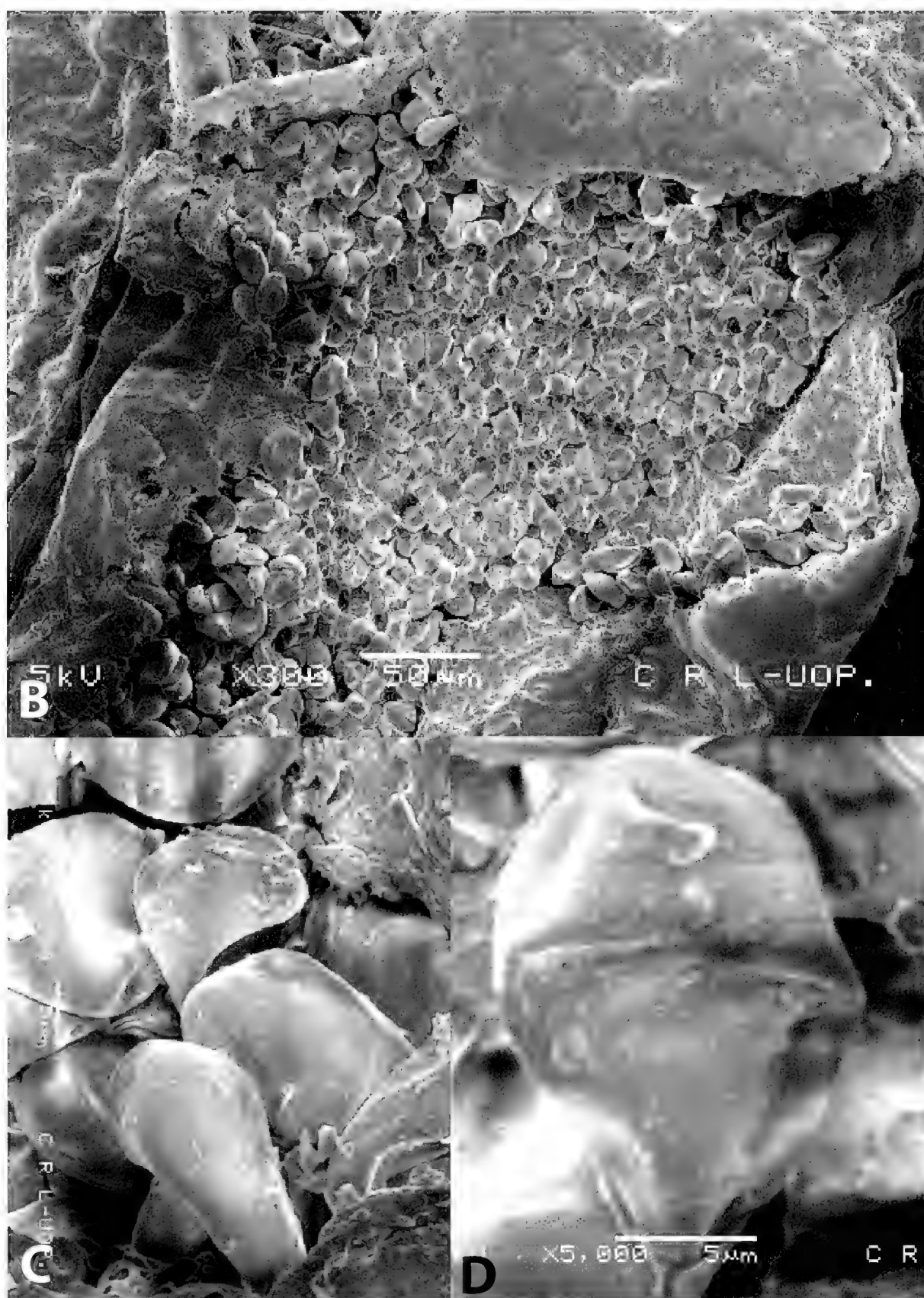


FIG. A: Lucida drawing of urediniospores of *Milesia kashmiriana* sp. nov. (type).
Scale bar = 12 µm.

COMMENTS: The uredinia of genera *Hyalopsora*, *Milesina* and *Uredinopsis* (*Pucciniastraceae*) are classified in the anamorph genus *Milesia*. *Milesia*



FIGS. B–D: *Milesia kashmiriana* sp. nov. (type)
 (B). Cross section of uridium containing uridinospores
 (C). SEM photograph of uridinospores (D). A finely echinulated uridinospore.

kashmiriana most probably belongs to the genus *Hyalopsora* because of the morphological characters of uridinospores and uridinia.

Urediniospores of *Milesia kashmiriana* and *Hyalopsora polypodii* (Pers.) Magnus 1901 resemble each other in urediniospore shape and wall ornamentation, but *H. polypodii* has shorter urediniospores (17–27 µm) with 3–5 scattered germ pores.

Urediniospores of *M. kashmiriana* are different from those of *H. hakodatensis* Hirats. f. 1932 in size and shape; *H. hakodatensis* has shorter urediniospores (20–27.5 µm).

Uredinopsis intermedia Kamei 1932 differs in its larger (12–30 × 18–32 µm), wedge-shaped or rhomboidal urediniospores.

Urediniospores of *M. kashmiriana* also differ from the larger (15–23 × 23–42 µm) spores of *H. diplazii* Hirats. f. 1940. Moreover, the absence of paraphyses and the presence of smooth to finely echinulate urediniospores distinguish *M. kashmiriana* from *H. diplazii*, which has a few paraphyses and distinctly verrucose urediniospores.

Milesia kashmiriana is similar to *Uredinopsis daisenensis* Hirats. f. 1936 in a few respects, but the presence of shorter urediniospores (21–37 µm vs. 21–43 µm) with smooth to finely echinulate wall ornamentation and the absence of beaks differentiates it from *U. daisenensis*.

Uredinopsis komagatakensis Hirats. f. 1943 has shorter (17–32 µm) urediniospores with smooth or few longitudinal lines of minute papillae on the spore walls that contrast with the smooth to finely echinulate urediniospores in *M. kashmiriana* has.

On the basis of the above-mentioned comparisons, the present species seems new to science but will be kept in the anamorph genus *Milesia* until the telial stage is discovered.

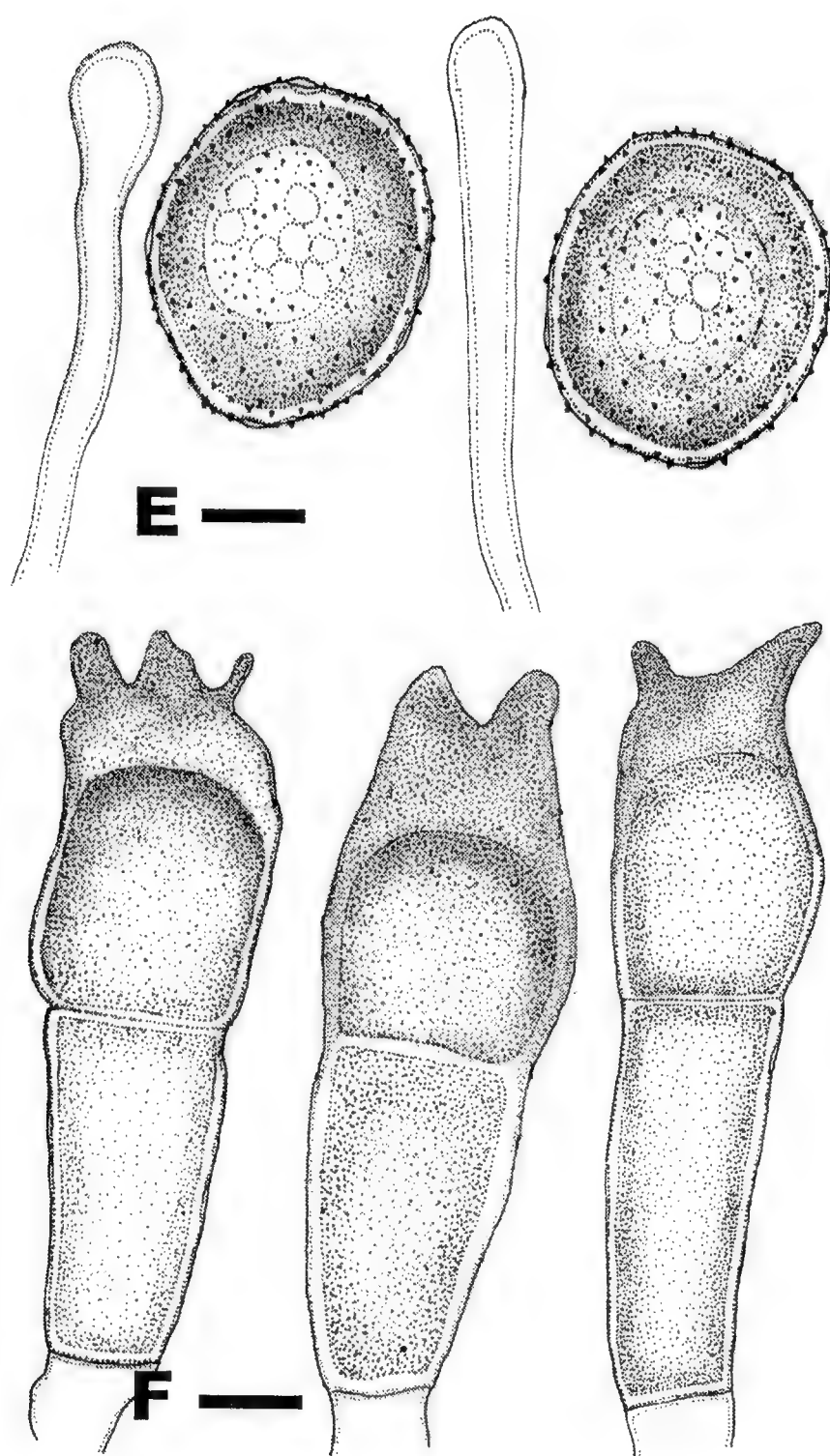
Puccinia coronata* var. *himalensis Barclay, Trans. Linn. Soc. London,

Bot., Ser. 2, 3: 227 (1891)

(Figs. E–F)

SPERMOGONIA and AECIA unknown. UREDINIA amphigenous, brown, 0.07–0.09 × 0.1–0.3 mm. UREDINIOSPORES globose-subglobose or ovoid, 13–19 × 14–21 µm; germ pores (2–) 4–8, scattered, obscure; wall 1.5–2 µm thick, pale yellow to nearly colorless, echinulate; pedicel minute, deciduous. PARAPHYSES clavate, apex 12–13 µm wide while 7–9 µm thick below, up to 50 µm long. TELIA amphigenous, long covered by the epidermis, or only tardily exposed, without paraphyses, blackish brown, sori 0.06–0.08 × 0.09–0.2 mm. TELIOSPORES golden to brown, paler basally, 14–19 × 27–47 (–54) µm, wall up to 2 µm thick at sides while about 2–5 µm thick apically excluding digitations, apex coronate with digitations, 4–12 µm long; pedicel short, yellowish brown to brown, 8–9 × 9–15 µm.

MATERIAL EXAMINED: On *Piptatherum vicarium* (Grigorj.) Roshev. (= *Oryzopsis microcarpa* Pilg.), with II, III stages, Pakistan, Azad Jammu & Kashmir, Neelum valley, Muchal, at 3000 m a.s.l., 03 November, 2006. NSA # 907. (LAH Herbarium No. NSA 1047).



FIGS. E–F: Lucida drawings of *Puccinia coronata* var. *himalensis*
(E). Echinulated urediniospores (F) Coronate teliospores.
Scale bar = 10 μ m.

COMMENTS: *Puccinia coronata* var. *avenae* W.P. Fraser & Ledingham 1933, *P. coronata* Corda 1837 var. *coronata*, and *P. coronata* var. *gibberosa* (Lagerh.) Jørst. 1949 have previously been reported from Pakistan (Afshan et al. 2008, Ahmad et al. 1997, Iqbal et al. 2008).

Puccinia coronata var. *himalensis* has been reported on different members of *Poaceae* from Europe to India, Japan and North and South America (Cummins

1971). The variety is a new record for Pakistan, and *Piptatherum vicarium* represents a new host for the *Uredinales*.

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References

- Afshan NS, Khalid AN, Niazi AR. 2008. New records of graminicolous rust fungi from Pakistan. Pak. J. Bot. 40(3): 1279–1283.
- Ahmad S, Iqbal SH, Khalid AN. 1997. Fungi of Pakistan. Sultan Ahmad Mycological Society of Pakistan, Department of Botany, University of the Punjab, Lahore, Pakistan.
- Cummins GB. 1971. The Rust Fungi of Cereals, Grasses and Bamboos. Springer Verlag Berlin-Heidelberg-New York.
- Iqbal SH, Khalid AN, Afshan NS, Niazi AR. 2008. Rust fungi on *Saccharum* species from Pakistan. Mycotaxon 106: 219–226.

***Cadophora malorum* and *Cryptosporiopsis ericae* isolated from medicinal plants of the *Orchidaceae* in China**

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Abstract —Two species in the anamorphic genera *Cadophora* and *Cryptosporiopsis* are newly recorded as endophytes from medicinal plants of the *Orchidaceae* in China. *Cadophora malorum* was isolated from a stem of *Bletilla striata* in Hubei Province, and *Cryptosporiopsis ericae* from a root of *Spiranthes sinensis* in Tibet. These are the first records of these fungi from plants of the *Orchidaceae*.

Key words — endophytic fungi, taxonomy

Introduction

Orchids are unique among plants in their modes of nutrition (myco-heterotrophy) involving direct and often obligate relationships with fungi (Leake 1994). Thus, fungi are critical for an orchid's growth and development. Orchid mycorrhizas have been historically regarded as the third distinct structural lineage of mycorrhizas in addition to ecto-related and arbuscular mycorrhizas (Imhof 2009). Recently, non-mycorrhizal endophytic fungi associated with orchids have been shown to serve as potential growth promoters and source of bioactivity substances (Guo & Wang 2001), implying further application in the fields of cultivation and natural medicine.

During a survey of endophytic fungi associated with traditional medicinal plants of *Bletilla striata* (Thunb.) Rchb.f. and *Spiranthes sinensis* (Pers.) Ames (*Orchidaceae*) in China, *Cadophora malorum* and *Cryptosporiopsis ericae* were isolated from plant tissues. These are the first records of these anamorphic species from orchids.

Materials and methods

Eighty-eight strains of endophytic fungi were isolated from healthy orchid plants of *Bletilla striata*, collected from Lichuan County, Hubei Province, and fifty-five strains from *Spiranthes sinensis*, collected from Linzhi County, Tibet. The isolation of endophytic fungi was performed by the modified method described by Bayman et al. (1997). In brief, roots and stems were surface-sterilized in a sequence of 75% ethanol for 1 min, 2.5% NaClO for 5 min, 75% ethanol for 1 min, and then rinsed in sterile distilled water. The endophytic fungi were first identified morphologically from published descriptions and the identifications confirmed through sequence analyses. After the extraction of genomic DNA from pure fungal cultures, the ITS regions were amplified and sequenced. Sequences were compared with fungal ITS sequences in GenBank using BLAST searches. These isolates are preserved as living cultures in the China General Microbiological Culture Collection Center, Institute of Microbiology, Chinese Academy of Sciences (CGMCC).

Taxonomy

Cadophora malorum (Kidd & Beaumont) W. Gams, Studies in Mycology 45: 188, 2000.

FIG. 1 A–B

COLONIES on PDA after 2 weeks in the dark at room temperature 2.0 cm diam, brown, usually with white margin. Mycelium superficial and immersed. Aerial mycelium bristly, composed of pale brown, smooth thick hyphae. Colony margin irregularly wavy. CONIDIOSPORES simple, straight or slight flexuous, hyaline and smooth, monophialidic phialides, integrated and terminal or discrete, ampulliform, lageniform with hyaline collarettes. CONIDIA simple, straight, oblong, rounded at the ends, colorless, smooth, $2\text{--}3 \times 0.3\text{--}0.5 \mu\text{m}$ (FIG. 1A–B).

SPECIMENS EXAMINED: CHINA: HUBEI PROVINCE, Lichuan County, in *Bletilla striata* (Orchidaceae) stem, 10 Sept. 2004, Zhi-Xia Meng BJ-10-1 (CGMCC10118)

REMARKS: *Cadophora* has been treated as a synonym of *Phialophora* (Conant 1937). Gams (2000) suggested using the generic name *Cadophora* for *Phialophora*-like species with affinities to the *Dermateaceae* in the *Helotiales*. Harrington & McNew (2003) molecular analyses supported Gams' view that members of the genus *Cadophora* were anamorphs of the *Helotiales* and distinguished from the morphologically similar anamorphic genus *Phialophora* in the *Chaetothyriales*. *Cadophora* species differ from true *Phialophora* species by pale to hyaline collarettes on top of their phialides (Gams 2000). In fact, morphological identification of the two genera was difficult because pigmentation in these species is often quite variable (Harrington & McNew 2003), making it necessary to combine morphological and molecular observations to identify

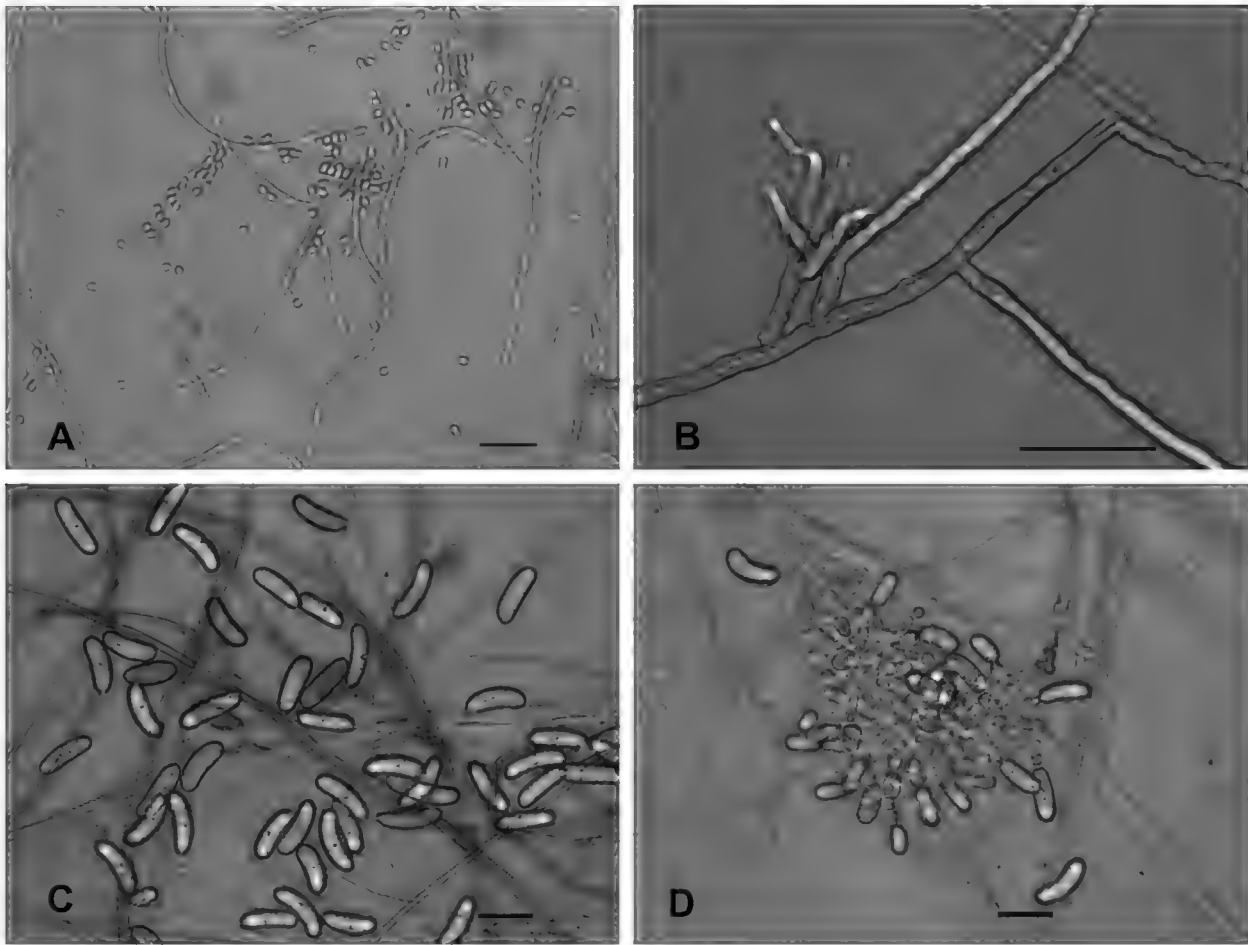


FIG. 1 *Cadophora malorum* (A–B) (CGMCC10118) and *Cryptosporiopsis ericae* (C–D) (CGMCC10119) showing conidia and phialides. Scale bar = 20µm

them. Morphology and ITS sequence (FJ450054) of our sample are identical to *C. malorum* (100% similarity with GenBank sequence DQ404350 from *Cadophora malorum*).

The known *Cadophora* species appear to be plant pathogens, root associates, or wood colonizers (Harrington & McNew 2003). *Cadophora malorum* is a common species in the genus that has been identified as a plant pathogen (Frisullo 2002). In our study, *C. malorum* was isolated from a stem of healthy *Bletilla striata*. The exact relationship between *C. malorum* and the orchid host plant needs further study.

Cryptosporiopsis ericae Sigler, Studies in Mycology 53: 57, 2005.

FIG. 1 C–D

COLONIES on PDA at room temperature after 21 d up to 8.0 cm diam, flat, felty, white to gray at the beginning and becoming grayish orange with age. Pale yellowish brown droplets occurred in the centre. Colony reverse gray orange when pigments produced. CONIDIOSPORES phialides, formed in hemispherical sporodochial conidiomata. Hyphae of young conidiomata moniliform and hyaline, older conidiomata composed of yellowish or black brown hyphae. CONIDIAL MASSES white initially, becoming to pale to golden yellow in age.

MACROCONIDIA cylindrical, slightly curved, rounded at the apex, nonseptate, smooth, hyaline, becoming to golden yellow and guttulate in age, $18\text{--}23 \times 5.5\text{--}7.8 \mu\text{m}$ (FIG. 1 C–D). MICROCONIDIA nonseptate, hyaline, oblong, $10\text{--}12 \times 4\text{--}5.5 \mu\text{m}$ (not shown).

SPECIMENS EXAMINED: CHINA: TIBET, in root *Spiranthes sinensis* (Orchidaceae), Aug. 2007, Zhi-Xia Meng SC-b-2 (CGMCC10119).

REMARKS: *Cryptosporiopsis ericae* was isolated and described from ericaceous plant roots from western North America (Sigler et al. 2005). Characteristics of conidiomata and conidia of our specimen coincided with the original description. Moreover, the ITS sequence of Chinese material (GU945547) was 99% identical to the *C. ericae* sequence (AY853167) in the GenBank database.

Many *Cryptosporiopsis* species are known from roots of woody plants, especially from ericaceous plants (Kowalski & Bartnik 1995, Verkley et al. 2003). The Chinese record is the first report of the species from herbaceous orchid plant root.

Although some species of *Cryptosporiopsis* (e.g. *C. radicola*, a frequent colonizer of oak roots) may be host specific, the precise ecological roles in host roots remain unknown (Kowalski & Bartnik 1995). *Cryptosporiopsis ericae* has been isolated from ericaceous roots, but Berch et al. (2002) found no formation of mycorrhizal structures (hyphal coils) in re-synthesis experiments done with salal (*Gaultheria shallon*) and *C. ericae*. Similarly, Wang et al. (2007) indicated that *C. ericae* was endophytic but non-mycorrhizal and non-pathogenic for their inoculated host, *Populus tremuloides* Michx.

In addition, cryptocandin (a unique lipopeptide antimycotic) has been described from *Cryptosporiopsis* sp. that might be useful clinically for the treatment of a variety of mycoses (Fischer et al. 1984, Strobel et al. 1999). The role of *C. ericae* in the medicinal host plant needs to be studied to establish whether it is associated with pharmacodynamic effects.

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Literature cited

- Bayman PL, Lebrón RL, Tremblay JL. 1997. Variation in endophytic fungi from roots and leaves of *Lepanthes* (Orchidaceae). *New Phytologist* 135: 143–149.
- Berch SM, Allen TR, Berbee ML. 2002. Molecular detection, community structure and phylogeny of ericoid mycorrhizal fungi. *Plant and Soil* 244: 55–66.

- Conant NF. 1937. The occurrence of a human pathogenic fungus as a saprophyte in nature. *Mycologia* 29: 597–598.
- Fischer PJ, Anson AE, Petrini O. 1984. Novel antibiotic activity of an endophytic *Cryptosporiopsis* sp. isolated from *Vaccinium myrtillus*. *Transactions of the British Mycological Society* 83: 145–148.
- Frisullo S. 2002. First report of *Cadophora malorum* on *Asparagus officinalis* in Italy. *Phytopathologia Mediterranea* 41(2): 148–151.
- Gams W. 2000. *Phialophora* and some similar morphologically little-differentiated anamorphs of divergent ascomycetes. *Studies in Mycology* 45: 187–199.
- Guo SX, Wang QY. 2001. Character and action of good strain on stimulating seed germination of *Gastrodia elata*. *Mycosystema* 20(3): 408–412.
- Harrington TC, McNew DL. 2003. Phylogenetic analysis places the phialophora-like anamorph genus *Cadophora* in the *Helotiales*. *Mycotaxon* 87: 141–151.
- Imhof S. 2009. Arbuscular, ecto-related, orchid mycorrhizas—three independent structural lineages towards mycoheterotrophy: implications for classification? *Mycorrhiza* 19: 357–363.
- Kowalski T, Bartnik C. 1995. *Cryptosporiopsis radicola* sp. nov. from roots of *Quercus robur*. *Mycological Research* 99: 663–666.
- Leake JR. 1994. The biology of myco-heterotrophic (saprophytic) plants. *New Phytologist* 127: 171–216.
- Sigler L, Allan T, Lim SR, Berch S, Berbee M. 2005. Two new *Cryptosporiopsis* species from roots of ericaceous hosts in western North America. *Studies in Mycology* 53: 53–62.
- Strobel GA, Miller RV, Martinez-Miller C, Condrón MM, Teplow DB, Hess WM. 1999. *Cryptocandin*, a potent antimycotic from the endophytic fungus *Cryptosporiopsis* cf. *quercina*. *Microbiology* 145: 1919–1926.
- Verkley GJM, Zijlstra JD, Summerbell RC, Berendse F. 2003. Phylogeny and taxonomy of root-inhabiting *Cryptosporiopsis* species, and *C. rhizophila* sp. nov., a fungus inhabiting roots of several Ericaceae. *Mycological Research* 107: 689–698.
- Wang W, Tsuneda A, Fe Gibas C, Currah RS. 2007. *Cryptosporiopsis* species isolated from the roots of aspen in central Alberta: identification, morphology, and interactions with the host, in vitro. *Canadian Journal of Botany* 85 (12): 1214–1226.

Geographic origins and phylogenetic affinities of the putative Hawaiian endemic *Rhodocollybia laulaha*

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Abstract — The Hawaiian mushroom *Rhodocollybia laulaha* was selected as a model to investigate patterns of gene flow between geographically isolated fungal populations from ecologically and bioclimatically varied sites. Its morphology (distinctive when compared to other members of the genus) and affinity for endemic Hawaiian forest suggested that it was endemic to Hawaii. However, speculation as to its closest non-Hawaiian relative and its overall placement within the genus was based on mostly anecdotal evidence. The present morphological and genetic research identifies a well-supported clade comprising *R. laulaha* individuals from across the Hawaiian Islands, reveals *R. lignitilis* (described in 2004 from the Neotropics) to be conspecific with *R. laulaha*, and identifies *R. unakensis* from Texas as a putative sister taxon. Different possible historical scenarios are discussed regarding the migration and establishment of *R. laulaha* ancestors between the Americas and Hawaii. *Rhodocollybia lignitilis* is synonymized with *R. laulaha*, and *Marasmius clavipes* is transferred to *Rhodocollybia*.

Key words — ITS, LSU, species range

Introduction

Rhodocollybia laulaha Desjardin et al. was described from the Hawaiian Islands in 1999. At that time, it was recognized as morphologically distinct

from other known *Rhodocollybia* species in having pale-orange to grayish-orange, labyrinthine, constricted lamellae (Desjardin et al. 1999). Its specific epithet 'laulaha' is the Hawaiian word for 'common and widespread'. Indeed *R. laulaha*'s range extends from the northwesternmost coast of Kauai to the southeasternmost corner of the Big Island and is present on all major islands in between. It fruits prolifically from July through December with peak mushroom production in August and September. In an analysis of the phenology and abundance of several putative Hawaiian endemic mushrooms, *R. laulaha* proved the most prolific mushroom producer of the taxa studied (Hemmes & Desjardin 2002). While its range extends the entire length of the modern Hawaiian Islands, it is significantly restricted by habitat. The forest habitat to which *Rhodocollybia laulaha* is limited (montane wet forest, montane mesic forest, lowland mesic forest, and lowland alien forest) is highly fragmented on the Hawaiian Islands creating a spatially subdivided system with forest 'islands' distributed across oceanic islands.

Rhodocollybia is a small genus with 35 species and subspecies described for the genus in online fungal databases (Farr et al. 2005) and an additional six neotropical species recently described from Costa Rica and Panama (Mata et al. 2004). Phylogenetic analyses utilizing nuclear large subunit (nLSU) and internal transcribed spacer (ITS) gene regions suggest that the genus *Rhodocollybia* is monophyletic and is most closely related to members of the genus *Lentinula* (Wilson & Desjardin 2005). Members of the genus *Rhodocollybia* are broadly distributed throughout temperate regions of North America and Europe and montane regions of Central America. A single *Rhodocollybia* species was described from Indonesia (*Rhodocollybia spissa* (A.W. Wilson et al.) A.W. Wilson & Desjardin; Wilson & Desjardin 2005), a single species from Thailand (*Marasmius clavipes* \rightarrow *Rhodocollybia clavipes*), and a single *Rhodocollybia* of uncertain specific identity has been reported from South Africa (van der Westhuizen & Eicker 1994, as *Collybia distorta* (Fr.) Quél.). A taxon similar in appearance to *Rhodocollybia butyracea* (Bull.) Lennox is common in Australia (G.M. Mueller, pers. com.). A phylogenetic reconstruction using nLSU data placed *Rhodocollybia laulaha* in the monophyletic clade containing other *Rhodocollybia* species from the New World (Wilson & Desjardin 2005).

Support for the populations of *R. laulaha* belonging to a single species endemic to the Hawaiian Islands was based solely on its morphological distinctiveness and its reliable association with endemic Hawaiian rain forest vegetation (Desjardin et al. 1999). Understanding of the role of long distance spore dispersal in the maintenance of fungal species cohesion is in its infancy. Some evidence suggests that fungal spores are seldom dispersed for distances greater than 100 meters indicating that despite rare long distance dispersal events, significant gene flow via spore dispersal even between islands within

Hawaii is quite unlikely (Bergemann & Miller 2002, Burnett 2003). Other evidence suggests that a single fungal species can sustain appreciable gene flow across virtually global distributions (James et al. 2001, Petersen & Hughes 2007), but the dispersal mechanisms in such cases remain unclear.

The possibility exists that a putatively endemic Hawaiian taxon like *R. laulaha* does not actually represent a single lineage but rather the descendents of multiple independent introductions. Global phylogeography studies of the upside-down jellyfish genus *Cassiopea* using mitochondrial haplotype data suggest that two species of *Cassiopea* within the Hawaiian Islands represent independent introductions during the last 100 years – one from the Indo-Pacific, the other from the Red Sea/Atlantic. Genetic data indicate that the two species of *Cassiopea* currently occupying the island of Oahu are separated by 14–40 million years of reproductive isolation despite nearly identical morphology (Holland et al. 2004).

The goal of the present study was to determine whether or not *R. laulaha* represents several lineages with independent introductions to the Hawaiian Islands or a single lineage and single migration event to Hawaii. Additionally, we sought to identify a potential geographic source for the ancestor(s) of *R. laulaha* and to estimate the number of introductions if more than one. This type of search for a ‘sister taxon’ is difficult, especially for organisms such as fungi with largely unknown distributions. A recent estimation of worldwide macrofungal diversity calculated only 16–41% of macrofungi to be known to science and that endemism levels for macrofungi may be as high as 40–72% (Mueller et al. 2007). Considering that there is an extreme paucity of data regarding native species of macrofungi from most global regions outside of Europe and North America, it is safe to say that our knowledge of fungal diversity and distribution is minimal.

Investigations of other taxonomic groups have led to hypotheses on the progenitors of Hawaiian radiations: members of the plant bug genus *Sarona* in Hawaii represent radiation of a single introduction from the Americas (Asquith 1995); the spectacular honeycreeper radiation appears to be the sister group to a New World cardueline finch (*Carpodacus mexicanus*) whose common ancestor traveled to Hawaii roughly 3.5 million years ago (Tarr & Fleischer 1995); and the well-known Hawaiian silversword alliance members are descendants of a single California tarweed migrant that moved to Hawaii probably about 5 million years ago (Baldwin & Robichaux 1995). Nevertheless, the sister clade of many Hawaiian radiations remains unclear including that of the large Hawaiian *Drosophilidae* radiation, whose common ancestor may have arrived in Hawaii before formation of the oldest modern high island of Kauai (Desalle 1995). Members of the spider genus *Tetragnatha* in Hawaii are thought to represent at least two independent origins in Hawaii (Gillespie et al. 1994). [Note: Some

TABLE 1. *Rhodocollybia* species and outgroup taxon included in the analysis of ITS sequence data.

SPECIES	HERBARIUM*	COLLECTION ID	GEOGRAPHIC ORIGIN	GENBANK ACCESSION
<i>G. dryophilus</i> (outgroup)	TENN	57012	Macon, Co., NC	DQ241781
<i>R. amica</i>	TENN	56662	Costa Rica	AF505754
<i>R. butyracea</i>	TENN	55660	Turkey	AY313289
<i>R. butyracea</i>	TENN	56303	Mexico	AY313290
<i>R. butyracea</i>	TENN	59317	Austria	AY313291
<i>R. butyracea</i>		PL 33	Czech Republic	EF062462
<i>R. butyracea</i>	TENN	55660	Turkey	AY256689
<i>R. butyracea</i>	TENN	53580	Sweden	AY313293
<i>R. butyracea</i>		cult. 8250	USA	AY313292
<i>R. butyracea</i>		OKM 2756	USA	DQ444317
<i>R. clavipes</i>	SFSU	DED 8151	Thailand	GU369941
<i>R. dotae</i>	NY	REH 7007	Costa Rica	AF505758
<i>R. laulaha</i>	SFSU	DEH 61492	Maui, HI	GU369942
<i>R. laulaha</i>	F	MRK 56	Big Island, HI	GU369943
<i>R. laulaha</i>	SFSU	DED 6393	Kauai, HI	GU369944
<i>R. laulaha</i>	F	MRK 57	Big Island, HI	GU369945
<i>R. laulaha</i>	F	MRK 58	Maui, HI	GU369946
<i>R. laulaha</i>	SFSU	DEH 502	Big Island, HI	GU369947
<i>R. laulaha</i>	SFSU	DEH 482	Big Island, HI	GU369948
<i>R. laulaha</i>	SFSU	DEH 847	Big Island, HI	GU369949
<i>R. laulaha</i>	SFSU	DEH 600	Kauai, HI	GU369950
<i>R. laulaha</i>	F	MRK 50	Big Island, HI	GU369951
<i>R. laulaha</i>	F	MRK 52	Big Island, HI	GU369952
<i>R. laulaha</i>	SFSU	DEH 952	Kauai, HI	GU369953
<i>R. laulaha</i>	SFSU	DEH 004	Kauai, HI	GU369954
<i>R. laulaha</i>	F	MRK 53	Big Island, HI	GU369955
<i>R. laulaha</i>	F	MRK 51	Big Island, HI	GU369956
<i>R. laulaha</i>	F	MRK 54	Big Island, HI	GU369957
<i>R. laulaha</i>	F	MRK 55	Big Island, HI	GU369958
<i>R. lignitilis</i>	NY	REH 7907	Panama	AF505753
<i>R. lignitilis</i>	TENN	56628	Costa Rica	GU369959
<i>R. maculata</i>	TENN	59459	USA	AY256688
<i>R. maculata</i>	TENN	59459	USA	AY313296
<i>R. maculata</i>	CFH	AFTOL ID 540	USA	DQ404383
<i>R. maculata</i>	TENN	56568	USA	AY313297
<i>R. pandipes</i>	TENN	59546	Dominican Republic	AY313288
<i>R. pandipes</i>	TENN	53838	Costa Rica	AY313294
<i>R. prolixa</i>	NY	EFM 1403	Costa Rica	AF505748
<i>R. tablensis</i>		EN 2066	Costa Rica	AF505755
<i>R. turpis</i>	TENN	58017	Costa Rica	AF505749
<i>R. unakensis</i>	TENN	58545	Beaumont, TX	AY313298

* TENN = University of Tennessee; SFSU = Harry D. Thiers Herbarium, San Francisco State University; NY = New York Botanical Garden; F = Field Museum of Natural History, Chicago, IL; CFH = Clark Fungal Herbarium, Worchester, MA.

portion of the Hawaiian island chain has been above water for 29 million years, so with potential island hopping, there is a possibility of the oldest age being around 29 my, not 5 my.]

Material and methods

Eleven Big Island, two Maui, and four Kauai *R. laulaha* specimens, a single Thai specimen (*Marasmius clavipes* = *Rhodocollybia clavipes*), and a single Costa Rican collection of *R. lignitilis* J.L. Mata & Halling were sequenced for the ITS locus using the fungal specific ITS primers ITS1F and ITS4. The following thermocycler PCR settings were used: 94°C (1 minute), 50°C (45 seconds), 50 to 72°C ramp (1 minute), 72°C (1 minute), repeat 30 times, 72°C, (7 minutes) – (Vilgalys and Hester, 1990). PCR products were run on an agarose gel and excised bands were cleaned using gelase. Cycle sequencing was conducted using Big Dye v. 3.1. A 3730 ABI capillary sequencer was used for sequencing. Sequences were aligned with twenty-one GenBank sequences representing ten *Rhodocollybia* species and a *Gymnopus dryophilus* (Bull.) Murrill outgroup sequence (TABLE 1). Alignment was carried out using *Clustal X 1.83* (Thompson et al., 1994) software with further manual alignment using *MacClade v. 3.7* (Maddison & Maddison 1997). Phylogenetic reconstructions were performed using *PAUP 4.0b10* (Swofford 2000). A heuristic parsimony search and bootstrapping were conducted using a random stepwise addition with 1000 replicates. Of 1011 total characters, 561 ambiguously aligned characters were excluded from the analysis resulting in a total of 105 parsimony informative characters.

Additionally, a separate data set comprising six *R. laulaha* specimens (one Big Island, three Maui, and two Kauai), two *R. lignitilis* specimens from Panama and Costa Rica, a *R. unakensis* (Murrill) Halling specimen from Texas, and five GenBank sequences

TABLE 2. *Rhodocollybia* species included in the analysis of LSU sequence data.

SPECIES	HERBARIUM*	COLLECTION ID	GEOGRAPHIC ORIGIN	GENBANK ACCESSION
<i>R. badiialba</i>	SFSU	DLL 9199	USA	AY639439
<i>R. butyracea</i> var. <i>asema</i>		GLM 46024	Germany	AY207163
<i>R. butyracea</i> var. <i>asema</i>	NY	REH 6705	USA	AY639440
<i>R. laulaha</i>	SFSU	DED 5873	Big Island, HI	AY639441
<i>R. laulaha</i>	F	MRK 120	Maui, HI	GU369960
<i>R. laulaha</i>	F	MRK 121	Maui, HI	GU369961
<i>R. laulaha</i>	F	MRK 123	Maui, HI	GU369962
<i>R. laulaha</i>	F	MRK 160	Kauai, HI	GU369963
<i>R. laulaha</i>	F	MRK 163	Kauai, HI	GU369964
<i>R. lignitilis</i>	NY	REH 7907	Panama	GU369965
<i>R. lignitilis</i>	TENN	56628	Costa Rica	GU369966
<i>R. maculata</i>	DU	RV94	USA	AF042597
<i>R. maculata</i>	CFH	AFTOL ID 540	USA	AY639880
<i>R. unakensis</i>	TENN	58545	Beaumont, TX	GU369967

* TENN = University of Tennessee; SFSU = Harry D. Thiers Herbarium, San Francisco State University; NY = New York Botanical Garden; F = Field Museum of Natural History, Chicago, IL; CFH = Clark Fungal Herbarium, Worchester, MA; DU = Duke University Fungal Herbarium.

representing three additional *Rhodocollybia* species was created for the 28S LSU locus using the 28S fungal specific primers LROR and LR6 (TABLE 2). PCR, sequencing, alignment, and analysis procedures were the same as for the ITS. The LSU internal primer LR3 was used in addition to the LROR and LR6 primers for sequencing. Of 835 total characters, 34 characters were parsimony informative. No positions in the alignment were ambiguous. Both data sets were also subjected to analysis using Bayesian methods (Ronquist & Huelsenbeck 2003) to obtain support statistics. Ten thousand trees resulted from 1,000,000 generations. Burn in was reached at 8500 trees.

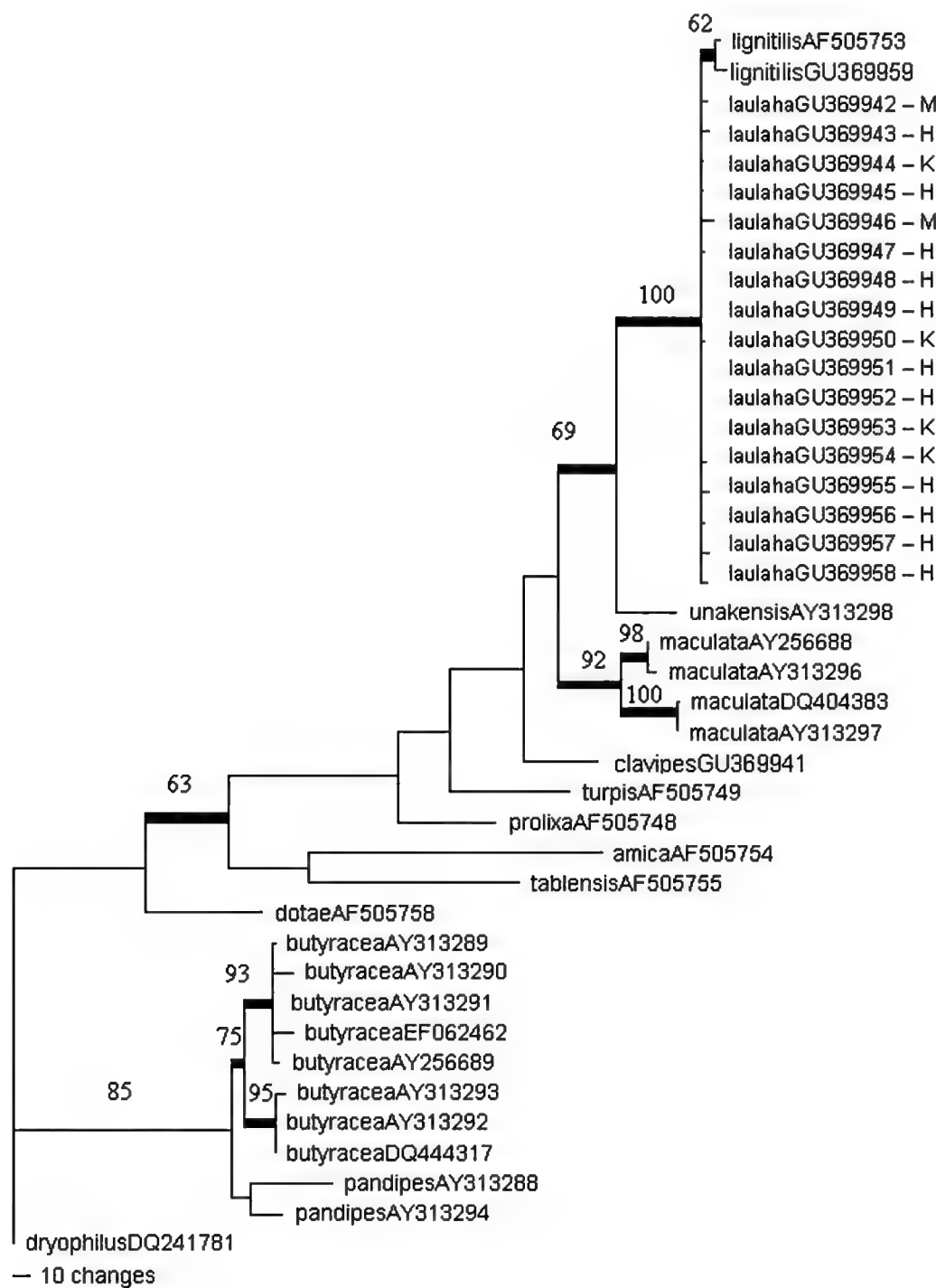


FIGURE 1. One of 52 equally most parsimonious trees of length 386 based on nuclear ribosomal ITS sequence data. Bootstrap support values greater than 60 appear above branches. Branches with Bayesian posterior probability values greater than 95% indicated as thickened branches. Island is indicated for seventeen *R. laulaha* collections (H=Big Island; M=Maui, K=Kauai).

Results

Both the ITS and LSU phylogenies (FIGS. 1–2) indicate that *R. lignitilis* from Panama and Costa Rica is nested within *R. laulaha* of Hawaii with bootstrap support values of 100 and 99 respectively and greater than 95% Bayesian posterior probability support in each analysis. Their closest relative included in this analysis is *R. unakensis* from Texas; however, the *R. laulaha* clade is significantly diverged from other *Rhodocollybia* species. The *R. laulaha* clade is within the Maculata subclade (as distinguished from the Butyracea subclade in Mata et al. 2004). Variability within the ITS region is not sufficient to discern patterns within the *R. laulaha* clade across the Hawaiian Islands or even between Hawaiian individuals and the two collections from the neotropics. *Marasmius clavipes* of Thailand nests clearly within the genus *Rhodocollybia* and is formally transferred herein to *Rhodocollybia*.

Rhodocollybia clavipes (Corner) Desjardin & Keirle, **comb. nov.**

MYCOBANK MB516790

BASIONYM: *Marasmius clavipes* Corner, Beih. Nova Hedwigia 111: 42. 1996.

TYPE: Borneo, Mt. Kinabalu, Mesilau, 1700 m elev., RSNB 8180A (E!).

ADDITIONAL MATERIAL EXAMINED: Thailand, Chiang Mai Province, Doi Inthanon National Park, Hwy 1009 at junction with road to Mae Chem, 28 June 2007, D.E. Desjardin 8151 (BBH, SFSU).

Discussion

It is perhaps not surprising that *R. lignitilis* appears to be conspecific with *R. laulaha* based on these molecular analyses. Despite the significant oceanic interruption in the species range, there are striking morphological similarities between the two taxa. Detailed examination of the protologues for *R. lignitilis* and *R. laulaha* indicates that the macromorphological and micromorphological features of the two are consistent and overlapping (cf. Desjardin et al., 1999 and Mata et al., 2004). As there are no fixed substitutions in the ITS of *R. lignitilis* that would permit reliable genetic differentiation between the two, it seems safe to declare them conspecific with the name *R. laulaha* having priority. Unfortunately, the neotropical population of *R. laulaha* is currently known from only two specimens: TENN 56628 from Costa Rica and R.E.H. no. 7907 from Panama. It is intriguing that a mushroom so common and so prolific in Hawaii has been collected on only two occasions in the neotropics, despite the fact that the specific collecting localities in Costa Rica and Panama from which it is known have been intensively sampled by mushroom biologists. Nonetheless, few mycologists focused on collecting *Rhodocollybia* in these areas and many of the *Rhodocollybia* described from Costa Rica and Panama are known from only a few specimens.

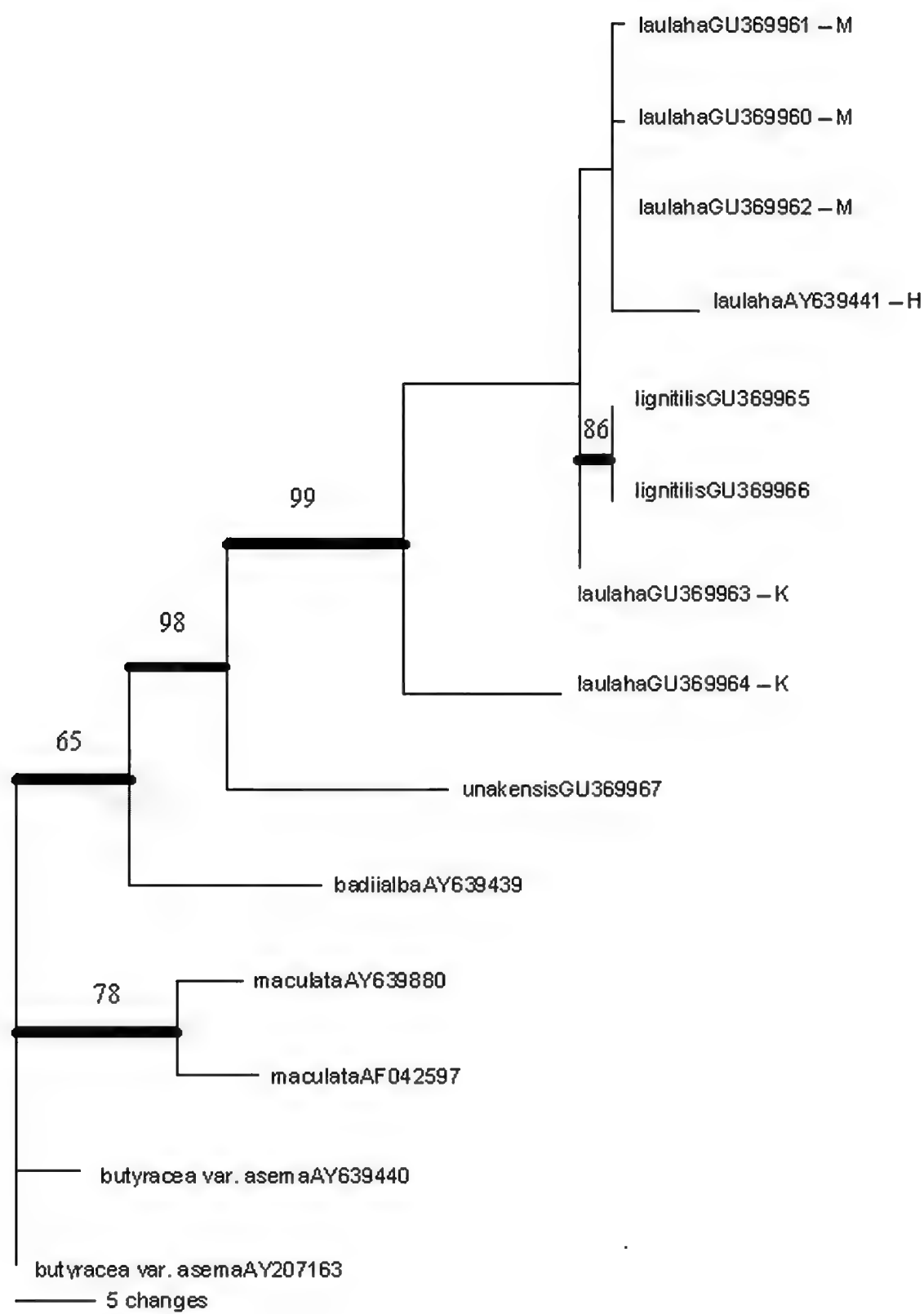


FIGURE 2. Single most parsimonious tree of length 71 based on nuclear ribosomal LSU sequence data. Bootstrap support values greater than 60 appear above branches. Branches with Bayesian posterior probability values greater than 95% indicated as thickened branches. Island is indicated for six *R. laulaha* collections (H=Big Island; M=Maui, K=Kauai).

Knowledge of this expanded range of *R. laulaha* into the neotropics allows for speculation about the biogeographic history of Hawaiian *Rhodocollybia*. The closest potential relative of *R. laulaha* (its sister taxon as recovered in the current analyses, which admittedly represents limited sampling) is *R. unakensis*. The specimen of *R. unakensis* used in this analysis was found near Beaumont, Texas (latitude 30.11°N), well within the North American subtropics. One cannot help but notice the connection between Hawaiian *Rhodocollybia* and *Rhodocollybia* in the Americas. The type collection from Unaka Springs, Tennessee, and the specimen we used in the analyses from Beaumont, Texas, are within the American subtropics. This would seem to be in line with many other Hawaiian taxa that also trace their ancestry to the New World (e.g. Baldwin & Robichaux 1995).

There are at least two straightforward scenarios that would explain the species distributions observed here. If *R. laulaha* originated in Hawaii, perhaps evolving from a New World ancestor that migrated west, the Costa Rican and Panamanian populations would represent relatively recent reverse migrations back to the Americas. If such a scenario were true, it might explain the relative lack of abundance of *R. laulaha* in the neotropics. Perhaps the oak forests of Central America provide a less than ideal habitat for this specialized Hawaiian endemic. Conversely, if *R. laulaha* originated in the New World and has only recently established in Hawaii, its rapid spread and colonization of Hawaiian endemic rain forests might reflect a case of 'ecological release' whereby constraints found in its native land are removed and it is able to expand its range and numbers with ease. Unfortunately, testing these conflicting hypotheses is not possible unless a considerable number of *R. laulaha* individuals can be collected from the neotropics. The latter scenario might appear more likely than the former in that it entails a single long distance migration event. However, without any way to assess the difficulty with which a mushroom species accomplishes such migration, it is impossible to argue that one migration event is any more likely than two events. Perhaps if appropriate genetic markers could be developed, a comparison of neutral and non-neutral markers or of synonymous and non-synonymous substitutions in a protein-coding marker might provide evidence in the Hawaiian *R. laulaha* populations of active positive selection or relaxed selection consistent with ecological release.

Clearly this investigation requires additional neotropical specimens. Ideally, with sufficient individuals representing the neotropics, multiple genetic markers might be able to determine current patterns of gene flow between Hawaii and the Americas (if realized) and the geography of origin – is *R. laulaha* Hawaiian or New World?

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References

- Asquith A. 1995. Evolution of *Sarona* (Heteroptera, Miridae): speciation on geographic and ecological islands. Pp. 90–120, in: Wagner WL, Funk VA (eds). Hawaiian biogeography on a hot spot archipelago. Smithsonian Institution Press..
- Baldwin BG, Robichaux RH. 1995. Historical biogeography and ecology of the Hawaiian silversword alliance (Asteraceae): new molecular phylogenetic perspectives. Pp. 259–287, in: Wagner WL, Funk VA (eds). Hawaiian biogeography on a hot spot archipelago. Smithsonian Institution Press.
- Bergemann SE, Miller SL. 2002. Size, distribution, and persistence of genets in local populations of the late-stage ectomycorrhizal basidiomycete, *Russula brevipes*. New Phytologist. 156 (2): 313–320.
- Burnett J. 2003. Fungal populations and species. Oxford University Press. 348 p.
- Desalle R. 1995. Molecular approaches to biogeographic analysis of Hawaiian *Drosophilidae*. Pp. 72–89, in: Wagner WL, Funk VA (eds). Hawaiian biogeography on a hot spot archipelago. Smithsonian Institution Press.
- Desjardin DE, Halling RE, Hemmes DE. 1999. Agaricales of the Hawaiian Islands. 5. The genera *Rhodocollybia* and *Gymnopus*. Mycologia. 91(1): 166–176.
- Farr DE, Rossman AY, Palm ME, McCray EB. 2005. Fungal databases. Systematic Botany & Mycology Laboratory. ARS. USDA.
- Gillespie RG, Croom HB, Palumbi SR. 1994. Multiple origins of a spider radiation in Hawaii. Proceedings of the National Academy of Sciences, USA. 91: 2290–2294.
- Hemmes DE, Desjardin DE. 2002. Mushrooms of Hawai'i. Ten Speed Press, Berkeley, California.
- Holland BS, Dawson MN, Crow GL, Hofmann DK. 2004. Global phylogeography of *Cassiopea* (Schyphozoa: Rhizostomeae): molecular evidence for cryptic species and multiple invasions of the Hawaiian Islands. Marine Biology. 145: 1119–1128.
- James TY, Moncalvo J, Li S, Vilgalys R. 2001. Polymorphism at the ribosomal DNA spacers and its relation to breeding structure of the widespread mushroom *Schizophyllum commune*. Genetics. 157: 149–161.

- Maddison WP, Maddison DR. 1997. MacClade v. 3.07. Sinauer Associates, Sunderland, Massachusetts.
- Mata JL, Halling RE, Hughes KW, Petersen RH. 2004. *Rhodocollybia* in Neotropical montane forests. *Mycological Progress* 3(4): 337–351.
- Mueller GM, Schmit JP, Leacock PR, Buyck B, Cifuentes J, Desjardin DE, Halling RE, Hjortstam K, Iturriaga T, Larsson K, Lodge DJ, May TW, Minter D, Rajchenberg M, Redhead SA, Ryvar den L, Trappe JM, Watling R, Wu Q. 2007. Global diversity and distribution of macrofungi. *Biodiversity and Conservation* 16(1): 37–48.
- Petersen RH, Hughes KW. 2007. Some agaric distribution patterns involving Pacific landmasses and Pacific Rim. *Mycoscience*. 48: 1–14.
- Ronquist F, Huelsenbeck JP. 2003. MRBAYES 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics* 19: 1572–1574.
- Swofford DL. 2000. PAUP Phylogenetic Analysis Using Parsimony and Other Methods v. 4.0b10. Sinauer Associates, Sunderland, Massachusetts.
- Tarr CL, Fleischer RC. 1995. Evolutionary relationships of the Hawaiian honeycreepers (*Aves*, *Drepanidinae*). Pp. 147–159, in: Wagner WL, Funk VA (eds). *Hawaiian biogeography on a hot spot archipelago*. Smithsonian Institution Press.
- Thompson JD, Higgins DG, Gibson TJ. 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignments through sequence weighting, position specific gap penalties and weight matrix choice. *Nucleic Acids Research*. 22:4673–4680.
- Vilgalys R, Hester M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. *Journal of Bacteriology*. 172(8): 4238–4246.
- van der Westhuizen GCA, Eicker A. 1994. *Mushrooms of Southern Africa*. Struik Publishers Ltd., Cape Town, South Africa. 207 p.
- Wilson AW, Desjardin DE. 2005. Phylogenetic relationships in the gymnopoid and marasmioid fungi (*Basidiomycetes*, euagarics clade). *Mycologia*. 97(3): 667–679.

***Jahnula morakotii* sp. nov. and *J. appendiculata* from a peat swamp in Thailand**

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Abstract — During a long-term study of wood colonization by freshwater fungi in the Sirindhorn peat swamp forest in the south of Thailand, two interesting *Jahnula* species were encountered. *Jahnula appendiculata* occurred commonly on eight species of timber, while *J. morakotii* occurred only once. *Jahnula morakotii* differs from all other *Jahnula* species in having the smallest ascospores with bipolar cellular appendages and lacking a sheath. The morphology of *J. morakotii* is illustrated and compared with other species in the genus.

Keywords — Ascomycota, colonization of wood, systematics

Introduction

During a long-term colonization study by freshwater fungi, of wood submerged in the Sirindhorn peat swamp forest, Narathiwat, in the south of Thailand, two *Jahnula* species were found. After several years of wood exposure, *Jahnula appendiculata* and *J. morakotii* were encountered. *Jahnula appendiculata* was found several times on test blocks of seven timber species after two to three years of submergence, while *J. morakotii*, was found only once on one timber species after the wood had been exposed for two years.

All thirteen *Jahnula* species that have been described occur in freshwater habitats and mostly from tropical regions (Hyde 1992, Hyde & Wong 1999, Pang et al. 2002, Pinruan et al. 2002, Raja & Shearer 2006, Raja et al. 2009). Thus far, *J. appendiculata* and *J. morakotii* are known only from the Sirindhorn peat swamp forest in Thailand (Pinruan et al. 2002 and this study) and may be restricted to this unique habitat (water pH 5.8–6.2, with a river system running through this acidic peat bog). *Jahnula appendiculata* was first described on a natural submerged palm trunk (Pinruan et al. 2002), while *J. morakotii* was collected on a single test block of *Azadirachta indica* var. *siamensis*. The

characteristic features of the new species include: globose to subglobose, always stalked, superficial ascomata, pseudoparaphysate hamathecium, bitunicate, fissitunicate asci, and brown, uniseptate ascospores with bipolar cellular appendages. These traits are congruent with taxa in the *Jahnulales*, especially the genus *Jahnula*. However, this fungus could not be assigned to any species currently included in *Jahnula* and is therefore described as new.

Materials and methods

Nine timber species (*Azadirachta indica* var. *siamensis* Valetton, *Erythrophleum teysmannii* Craib, *Melaleuca cajuputi* Powell, *Shorea obtusa* Wall., *S. roxburghii* G. Don, *S. siamensis* Miq., *Wrightia tomentosa* Roem. & Schult., *Xylia xylocarpa* (Roxb.) W. Theob., *Zollingeria dongnaiensis* Pierre) were submerged in the Sirindhorn peat swamp forest in Narathiwat Province, Thailand on 12 March 2001 in order to follow their colonization by freshwater fungi over a 10-year period. Twelve sets of test blocks ($15 \times 2.5 \times 2.5$ cm³, 5 blocks per set for each timber species), free of preservative, were threaded on a nylon rope and autoclaved 3 times before submergence in the Sirindhorn peat swamp forest in Narathiwat.

Nine sets of test blocks (one of each timber species) were recovered at 1 and 6 months, and 1, 2 and 3 years and returned to the laboratory in a clean polystyrene foam box. Test blocks were washed with stream water to remove silt and mud from the surface. Each set of test blocks was separated and single blocks were placed in pre-sterilized plastic boxes with moist tissue papers layered on the bottom. Test blocks were incubated at 20°C in a cabinet with cool white fluorescent light. Test blocks were examined for sporulating fungi after one week, and 1, 2 and 3 months following removal from the river. Assessment procedures were as described by Sivichai et al. (2002).

Material was examined using a stereomicroscope and fungi isolated and identified. Preparations were mounted in lactophenol-cotton blue, and sealed with polyvinyl alcohol. Single-ascospore isolations were made and grown on Corn Meal Agar (CMA, Difco?). Ascospores were spread over the agar surface with a flame-sterilized inoculation loop dipped in 0.05% (w/v) Triton X-100. Plates were incubated at 20°C in a cabinet with cool, white fluorescent light and examined with a microscope each day for signs of germination. Six to eight germinated ascospores were transferred to new plates and incubated in the same cabinet. Dried specimens are deposited in the BIOTEC Bangkok Herbarium (BBH #27681).

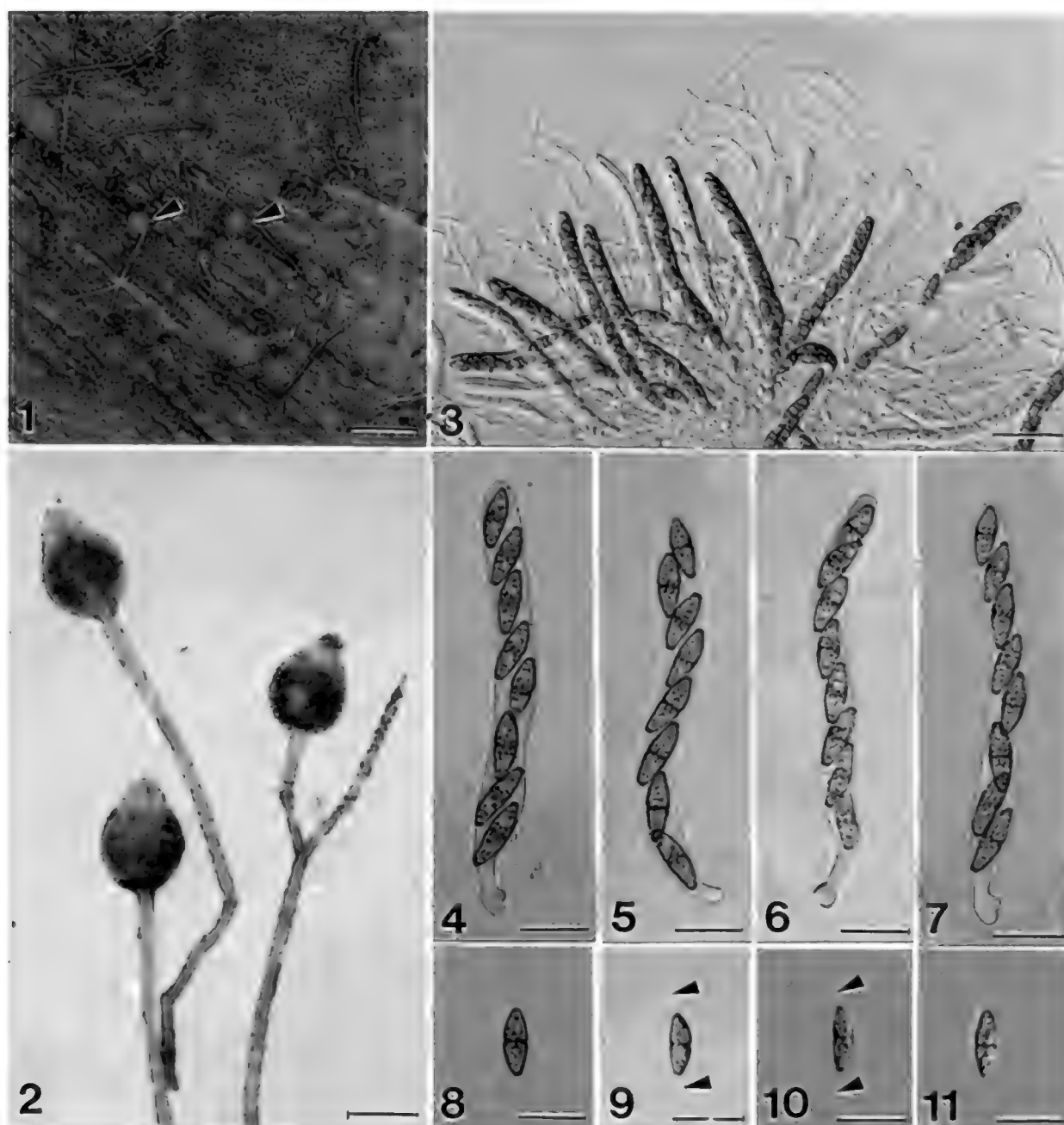
Taxonomic description

Jahnula morakotii Sivichai & Boonyuen, sp. nov.

FIGS. 1–11

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Ascomata 100–180 µm diametro, globosa ad subglobosa, gregaria, superficialia cum caule vel sessilia. *Pseudoparaphyses* septatae, hyalinae 1.5–2 µm lata, ca. 150 µm longis. *Asci* 107.5–120 × 9–11.5 µm, octospori, cylindrici, pedicellati, bitunicati, fissitunicati, camera oculari et annulo tenui instructi. *Ascosporae* 17.5–20 × 5–6.5 µm, fusiformae?, brunneae, guttulatae uniseriatae vel biseriatae, uniseptatae, constrictae, rectae vel aliquantum curvatae, duobus appendicibus cellularibus terminalibus longis hyalinis praeditae.



FIGS. 1–11. *Jahnula morakotii*. (Holotype SS2447). 1. Superficial ascomata on test block (arrowed). 2. Ascomata with long and septate stalks. 3. Squash mount of asci and pseudoparaphyses. 4–7. Cylindrical asci with pedicels. 8–11. Ascospores with bipolar appendages (arrowed).

Measure bars for FIG. 1 = 200 μ m. FIG. 2 = 100 μ m. FIG. 3 = 30 μ m. FIGS. 4–11 = 20 μ m.

HOLOTYPE: Thailand. Narathiwat: Sirindhorn peat swamp forest on submerged wood test block (*Azadirachta indica*), 10 March 2003 by Somsak Sivichai & Nattawut Boonyuen, BIOTEC SS2447.

ETYMOLOGY: “*morakotii*” in honor of Professor Morakot Tanticharoen, the past director of BIOTEC: National Center for Genetic Engineering and Biotechnology, who supports our Mycology Laboratory in Thailand.

Ascomata 100–180 μ m diam, globose to subglobose, superficial with septate stalk, 18–30 μ m wide, or sessile (FIGS. 1–2). Peridial wall of large, thin-walled cells. Pseudoparaphyses septate, hyaline, 1.5–2 μ m wide, up to 150 μ m in length

(FIG. 3). Asci $107.5\text{--}120 \times 9\text{--}11.5 \mu\text{m}$ (mean = $116 \times 11 \mu\text{m}$, $n = 50$), 8-spored, cylindrical, pedicellate, bitunicate, fissitunicate, with a shallow ocular chamber and faint ring (FIGS. 3–7). Ascospores $17.5\text{--}20 \times 5\text{--}6.5 \mu\text{m}$ (mean = $19 \times 6 \mu\text{m}$, $n = 50$), fusiform, brown, multi-guttulate, uniseriate or biseriate, slightly constricted at the septa, straight to curved with cellular bipolar hyaline apical appendages.

HABITAT: Saprobic on submerged wood test block (*Azadirachta indica*) in peat swamp forest.

GEOGRAPHICAL DISTRIBUTION: Thailand.

COMMENTS: *Jahnula morakotii* was collected only once on an *Azadirachta indica* test block, and it can be considered a rare fungus. *Jahnula morakotii* differs from all *Jahnula* species in having the smallest ascospores among all described species ($17.5\text{--}20 \times 5\text{--}6.5 \mu\text{m}$). Species most similar in ascospore size to *J. morakotii* are *J. bipileata* Raja & Shearer ($25\text{--}30 \times 9\text{--}10 \mu\text{m}$) and *J. australiensis* K.D. Hyde ($19\text{--}30 \times 6\text{--}8 \mu\text{m}$), however, they lack the bipolar appendages of *J. morakotii* (Raja & Shearer 2006). *Jahnula appendiculata* is the only other species with bipolar appendages but the ascospores of this species are longer and wider ($45\text{--}52.5 \times 22.5\text{--}27.5 \mu\text{m}$) than those of *J. morakotii* ($17.5\text{--}20 \times 5\text{--}6.5 \mu\text{m}$). In addition, ascospores of *J. appendiculata* have a thick sheath that is absent in *J. morakotii* (Pinruan et al. 2002).

Jahnula appendiculata Pinruan, K.D. Hyde & E.B.G. Jones, Sydowia

54(2): 243. 2002.

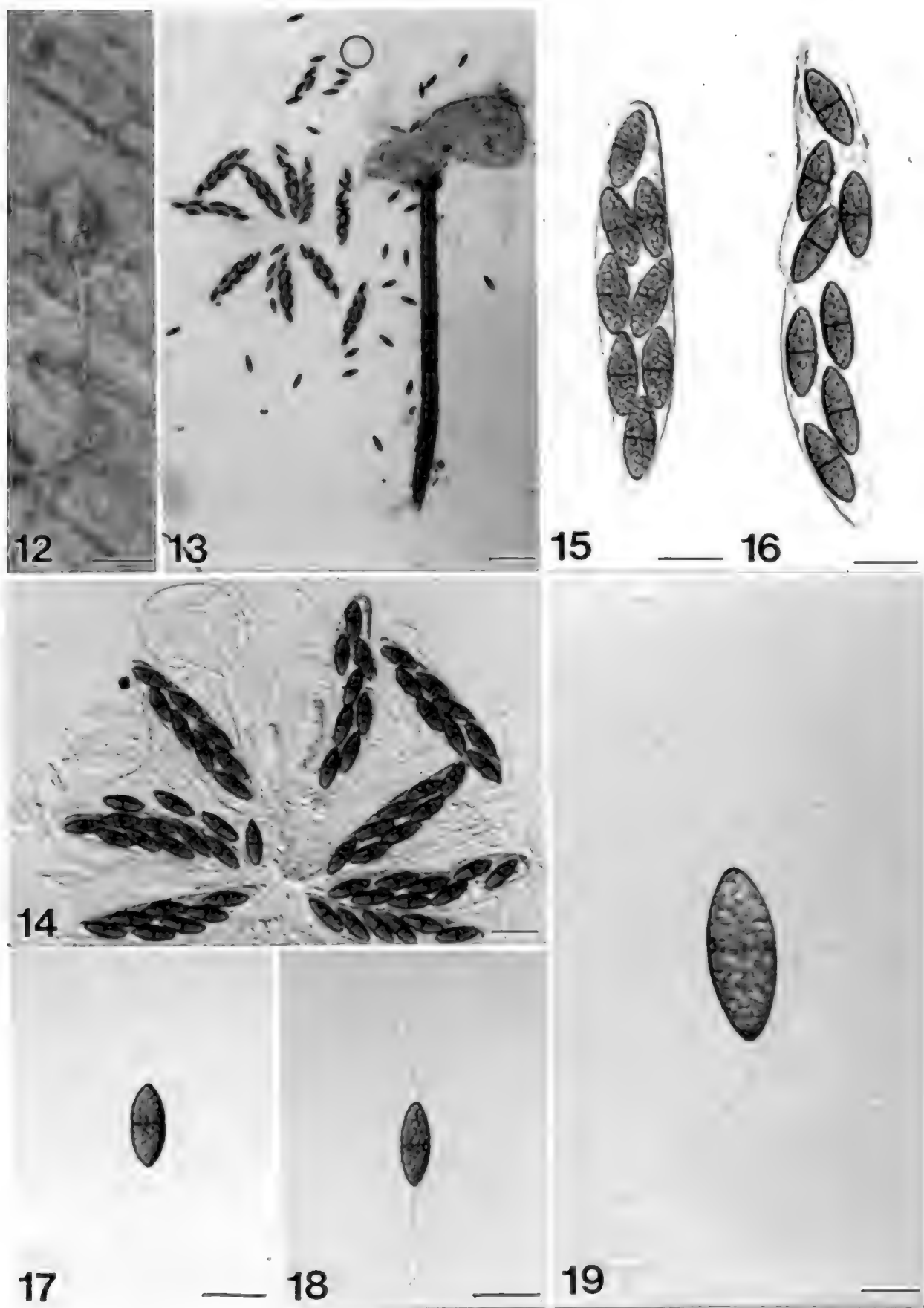
FIGS. 12–19

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Ascomata $280\text{--}350 \mu\text{m}$ in diam, pale brown, globose to subglobose, semi-immersed, becoming erumpent, but with the base remaining immersed, or superficial with stalk attached to the base (FIG. 12), stalk up to 2 mm long and $65 \mu\text{m}$ wide, brown (FIG. 13). Pseudoparaphyses septate, hyaline, $2\text{--}3 \mu\text{m}$ wide and up to $500 \mu\text{m}$ long, filamentous, septate, unbranching (FIG. 14).

Asci $320\text{--}450 \times 38\text{--}45 \mu\text{m}$ (mean = $400 \times 42 \mu\text{m}$, $n = 50$) (FIGS. 14–16), 8-spored, cylindrical to cylindric-clavate, pedicellate, bitunicate, fissitunicate (FIG. 16), with a shallow ocular chamber and faint ring (FIGS. 15–16). Ascospores $45\text{--}52.5 \times 22.5\text{--}27.5 \mu\text{m}$ (mean = $49 \times 25 \mu\text{m}$, $n = 100$), ellipsoid-fusiform, apices pointed, brown, guttulate, uniseptate, uniseriate or biseriate, slightly constricted at the septa, wall minutely verrucose, ascospore surrounded by a thick mucilaginous sheath, ends with a small subapical hood-like rim, and a long, appendage arising from both apices, up to $150 \mu\text{m}$ long and $5 \mu\text{m}$ diam. (FIGS. 17–19).

HABITAT: Freshwater. Saprobic on submerged wood (*Azadirachta indica* var. *siamensis*, *Erythrophleum teysmannii*, *Melaleuca cajuputi*, *Shorea obtusa*,



FIGS. 12–19. *Jahnula appendiculata*. 12. Superficial ascoma with stalk on test block. 13. Squash mount of an ascoma with a long septate stalk. 14. Squash mount of asci and pseudoparaphyses. 15–16. Cylindric-clavate asci. 17–19. Ascospores with bipolar appendages and a thick mucilaginous sheath.

Measure bars for FIG. 12 = 500 μ m. FIG. 13 = 100 μ m. FIG. 14 = 50 μ m. FIGS. 15–18 = 40 μ m. FIG. 19 = 20 μ m.

S. roxburghii, *Wrightia tomentosa*, *Xylia xylocarpa*, *Zollingeria dongnaiensis*) in a peat swamp forest.

GEOGRAPHICAL DISTRIBUTION: Thailand.

SPECIMENS EXAMINED: **Thailand. Narathiwat:** Sirindhorn peat swamp forest on submerged test blocks (*M. cajuputi*), BIOTEC SS2414; BIOTEC SS2415; (*W. tomentosa*), BIOTEC SS2429; (*X. xylocarpa*), BIOTEC SS2438; (*A. indica*), BIOTEC SS2448; (*S. obtusa*), BIOTEC SS2466; 22 February 2003, Somsak Sivichai & Nattawut Boonyuen; (*E. teysmannii*), BIOTEC SS2900; (*X. xylocarpa*), BIOTEC SS2903; (*M. cajuputi*), BIOTEC SS2906; (*A. indica*), BIOTEC SS2911; BIOTEC SS2915; (*Z. dongnaiensis*), BIOTEC SS2922; (*S. roxburghii*), BIOTEC SS2924; (*S. obtusa*), BIOTEC SS2934; 30 January 2004, Somsak Sivichai & Nattawut Boonyuen.

COMMENTS: Morphological features of *J. appendiculata* from our study agree with the type collection reported by Pinruan et al. (2002). Ascospore size in this study agrees with the range that was reported for the type specimen, as did measurements for the ascomata and asci. All major characters also agreed with the holotype specimen. Pinruan et al. (2002) noted that the frequency of occurrence of *J. appendiculata* was 1.7% and regarded this species as a common fungus. In this study, seven of the nine timber species were colonized by *J. appendiculata* but the fungus did not occur on *E. teysmannii* and *S. siamensis*. *Jahnula appendiculata* is known only from one site and therefore may be well adapted to the acidic waters of the peat swamp forest. Moreover, it has not been collected on natural submerged wood and test blocks at other test sites (e.g. Khao Yai National Park, Doi Inthano National Park, Kaeng Krachan National Park, and Khao Sok National Park, Thailand, in the past eight years.

Acknowledgements

We would like to thank Prof. Carol Shearer and Dr. Ka-Lai Pang for their comments and suggestions for the improvement of the manuscript, and Dr. Shaun R. Pennycook for assistance with formatting the article. This work was supported by the TRF/BIOTEC special Programme for Biodiversity Research and Training grant BRT R_647001. We would like to thank Profs. Morakot Tanticharoen and Gareth Jones, Drs. Kanyawim Kirtikara and Nigel Hywel-Jones at BIOTEC for their constant interest and support in our study.

Literature cited

- Hyde KD. 1992. Tropical Australian freshwater fungi. II. *Annulatascus velatispora* gen. et sp. nov., *A. bipolaris* sp. nov. and *Nais aquatica* sp. nov. (*Ascomycetes*). Australian Systematic Botany 5: 117–124.
- Hyde KD, Wong SW. 1999. Tropical Australian freshwater fungi. XV. The ascomycete genus *Jahnula*, with five new species and one new combination. Nova Hedwigia 68: 489–509.
- Pang KL, Abdel-Wahab MA, Sivichai S, Jones EBG. 2002. *Jahnulales* (*Dothideomycetes*, *Ascomycota*): a new order of lignicolous freshwater ascomycetes. Mycological Research 106: 1031–1042.

- Pinruan U, Jones EBG, Hyde KD. 2002 Aquatic fungi from peat swamp palms: *Jahnula appendiculata* sp. nov. *Sydowia* 54: 242–247.
- Raja HA, Carter A, Platt HW, Shearer CA. 2008. Freshwater ascomycetes: *Jahnula apiospora* (*Jahnulales*, *Dothideomycetes*), a new species from Prince Edward Island, Canada. *Mycoscience* 49: 326–328.
- Raja H, Shearer CA. 2006. *Jahnula* species from North and Central America, including three new species. *Mycologia* 98: 319–332.
- Sivichai S, Jones EBG, Hywel-Jones NL. 2002. Fungal colonization of wood in a freshwater stream at Tad Ta Phu, Khao Yai National Park, Thailand. *Fungal Diversity* 10: 113–129.

***Puccinia anaphalidis-virgatae*, a new species, and a new variety of rust fungi from Fairy Meadows, Northern Pakistan**

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Abstract — *Puccinia anaphalidis-virgatae* on *Anaphalis virgata* is described as a new species from Pakistan. Previous records of rusts on genus *Anaphalis* have been species of *Miyagia*, *Phakopsora*, and *Uromyces*; this is the first *Puccinia* species recorded on this host genus. A new variety *P. helictotrichi* var. *pakistanica* is described based on its resemblance to *P. helictotrichi*; however, it differs in size and number of germ pores of urediniospores and apical thickness of teliospores.

Key words — *Miyagia*, Nanga Parbat, *Phakopsora anaphalidis-adnatae*, *Pucciniales*, rust mycobiota

Introduction

This paper is a continuation of our publications describing the rust fungi of Pakistan. The taxa presented and described in this paper were collected from Fairy Meadows, Northern Pakistan. Out of all rust fungi previously recorded from Pakistan, 68 species of rust fungi have been reported from northern areas of Pakistan with only 12 taxa from Fairy Meadows, including one species each of *Aecidium*, *Chrysomyxa*, *Cronartium*, *Hyalopsora*, *Melampsora*, and *Pucciniastrum* and six species of *Puccinia* (Afshan et al. 2009, Iqbal et al. 2009).

Numerous new records and new species can still be expected as a result of ongoing fieldwork in these areas of Pakistan because of the high diversity of vascular plants i.e. 3000 species (Iqbal et al. 2009). During recent rust surveys in northern areas of Pakistan, one specimen was determined to be new to science, i.e., *Puccinia anaphalidis-virgatae* on *Anaphalis virgata*. *Puccinia helictotrichi*

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var. *pakistanica* on *Helictotrichon virescens* is also being proposed as new to science. The present paper contributes to the knowledge of the rust mycobiota of Fairy Meadows, Northern Pakistan.

Materials and methods

Specimens were collected from Fairy Meadows, Pakistan. Freehand sections of infected tissues and spores were mounted in lactophenol and gently heated to boiling. The preparations were observed under a NIKON YS 100 microscope and photographed with JSM5910 Scanning Electron Microscope. For SEM, dried plant material was hand-sectioned with a razor blade and mounted on SEM stubs. The samples were coated with gold in a sputter-coater and examined with a JSM5910 Scanning Electron Microscope. Spores and paraphyses were drawn using a Camera Lucida (Ernst Leitz Wetzlar, Germany). Spores were measured with an ocular micrometer. At least 25 spores were measured for each spore state. The specimens were deposited in the Herbarium of the Botany Department, University of the Punjab, Lahore (LAH).

Enumeration of taxa

***Puccinia anaphalidis-virgatae* Khalid, Afshan & S.H. Iqbal, sp. nov.** FIGS. A–H

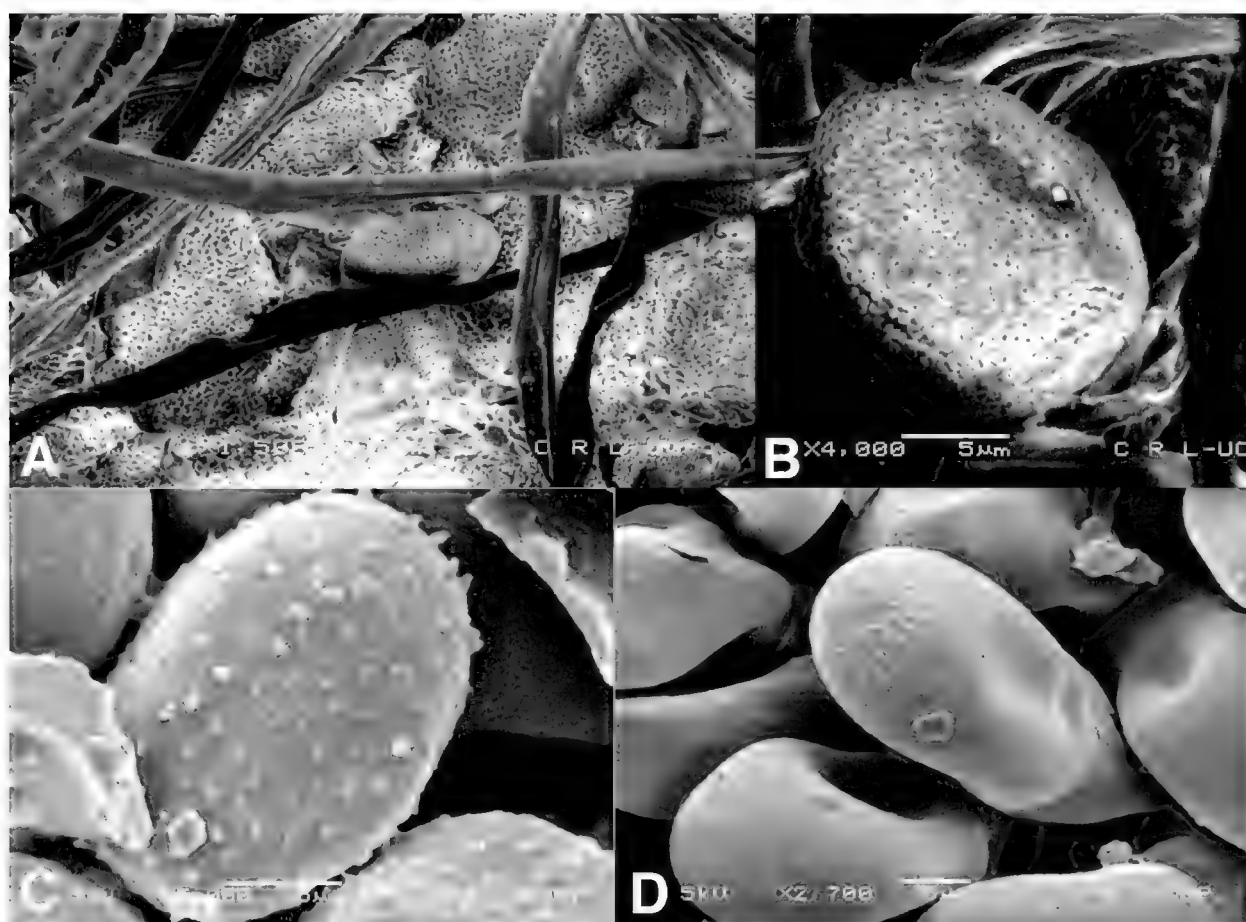
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Aeciosporae ovoideae, obovoideae vel ellipsoideae, hyalinae vel dilute flavidae, densiter verrucosae vel coronatae, $19\text{--}22 \times 21\text{--}29\ \mu\text{m}$. *Cellulis peridii* irregularibus, $47\text{--}65 \times 20\text{--}29\ \mu\text{m}$, hyalinis vel dilute flavidis. *Uredinia* in pagina abaxiali foliorum, $0.7\text{--}2.0 \times 4\text{--}7\ \text{mm}$, aureo-brunnea. *Urediniosporae* globosae vel subglobosae, $17\text{--}24 \times 20\text{--}28\ \mu\text{m}$; pariete $1.5\text{--}2\ \mu\text{m}$ crasso, echinulato, pallide flavido vel dilute brunneo; poris germinationis $5\text{--}6$, dispersis; paraphysibus clavatis, hyalinis vel dilute flavidis, $5\text{--}7 \times 55\text{--}72\ \mu\text{m}$; pedicellis $4\text{--}8 \times 10\text{--}25\ \mu\text{m}$. *Telia atra*, $0.9\text{--}2 \times 2\text{--}7\ \text{mm}$. *Teliosporae* 2-cellulares, raro unicellulares, aureo-brunneae vel castaneo-brunneae, oblongae, fusiformes, ellipsoideae vel late ellipsoideae, $20\text{--}24(-26) \times 50\text{--}64(-70)\ \mu\text{m}$; apicaliter castaneo-brunneae, basaliter pallidae, apice obtuso, conico vel oblique conico, $5\text{--}10\ \mu\text{m}$ crasso, pariete $1.5\text{--}2\ \mu\text{m}$ crasso, levi, pedicellis persistentibus, hyalinis vel dilute brunneis, $8\text{--}13 \times 32\text{--}50\ \mu\text{m}$.

HOLOTYPE: On *Anaphalis virgata* Thomson ex C.B. Clarke (Asteraceae), I + II + III, Pakistan, Northern Areas, Fairy Meadows, 3036 m a.s.l., 12 Aug 2007. NSA # G01 (LAH - NSA 1004).

ETYMOLOGY: Named after the host plant *Anaphalis virgata*.

SPERMOGONIA not found. AECIA on stems, orange, $0.1\text{--}0.2 \times 0.2\text{--}0.3\ \text{mm}$, cupulate. AECIOSPORES ovoid to obovoid or ellipsoid, hyaline to pale yellow, finely verrucose to coronate, $19\text{--}22 \times 21\text{--}29\ \mu\text{m}$. Peridial cells irregular to fusiform in shape, moderately rugose, $47\text{--}65 \times 20\text{--}29\ \mu\text{m}$, hyaline to pale yellow. UREDINIA on leaves and stems, abaxial, $0.7\text{--}2 \times 4\text{--}7\ \text{mm}$, golden brown. UREDINIOSPORES globose to subglobose, $17\text{--}24 \times 20\text{--}28\ \mu\text{m}$; wall $1.5\text{--}2\ \mu\text{m}$

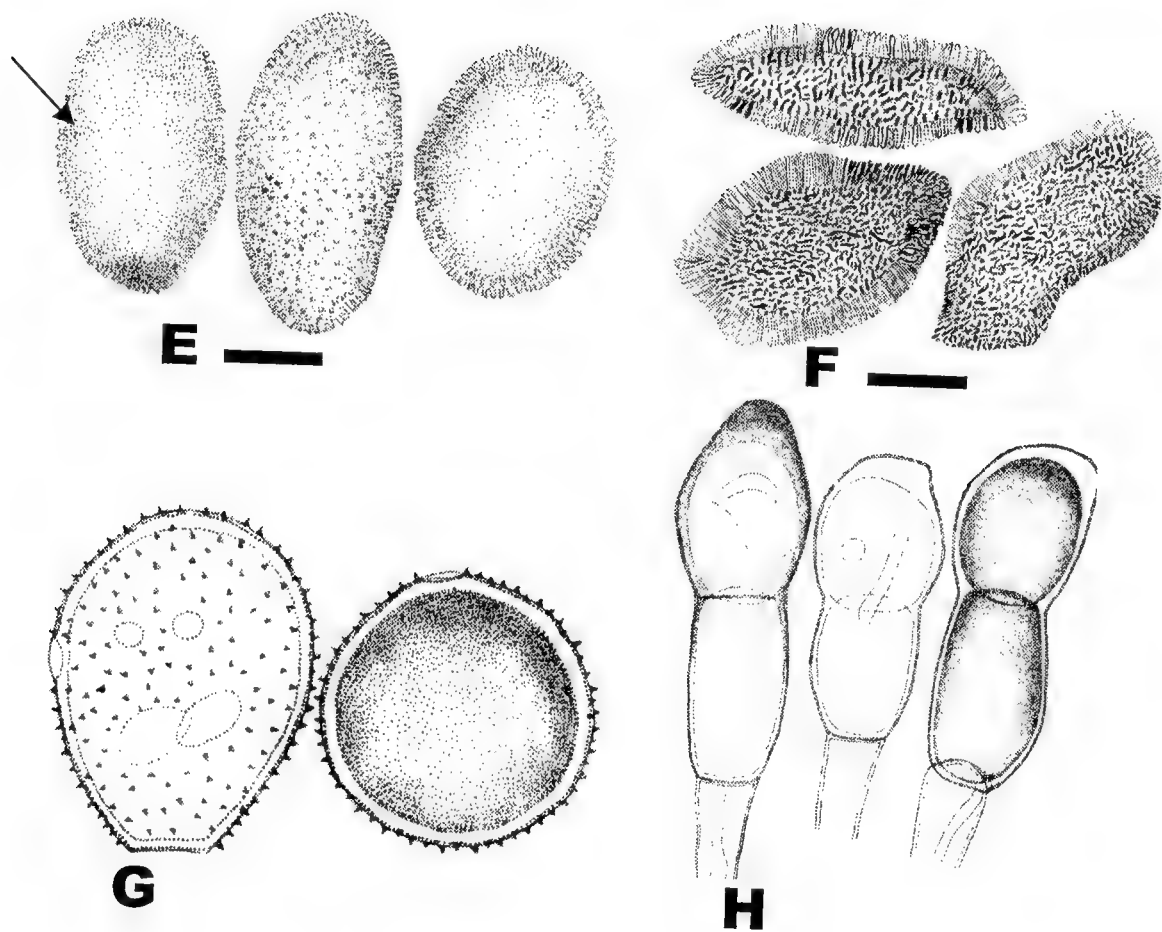


FIGS. A–D: *Puccinia anaphalidis-virgatae* (type) (A) SEM photograph of peridial cells and aeciospores. (B) An aeciospore showing verrucose wall ornamentation. (C) Echinulate urediniospores. (D) SEM photograph of smooth walled teliospores.

thick, pale yellow to pale brown, sparsely echinulate; germ pores 5–6, scattered; paraphyses clavate, hyaline to pale yellow, $5\text{--}7 \times 55\text{--}72\text{ }\mu\text{m}$; pedicel fragile, $4\text{--}8 \times 10\text{--}25\text{ }\mu\text{m}$. TELIA on stems, black, $0.9\text{--}2 \times 2\text{--}7\text{ mm}$. TELIOSPORES mostly two-celled, few one-celled, golden brown to chestnut brown, oblong to fusiform or ellipsoid to broadly ellipsoid, $20\text{--}24(\text{--}26) \times 50\text{--}64(\text{--}70)\text{ }\mu\text{m}$; apex chestnut brown, paler basally, apex mostly rounded but sometimes conical or obliquely conical, $5\text{--}10\text{ }\mu\text{m}$ thick; wall $1.5\text{--}2\text{ }\mu\text{m}$ thick, smooth; pedicel persistent, hyaline to pale brown, $8\text{--}13 \times 32\text{--}50\text{ }\mu\text{m}$.

COMMENTS: Previously, *Phakopsora anaphalidis-adnatae* Khalid & S.H. Iqbal was reported on *Anaphalis adnata* DC. from Pakistan (Khalid & Iqbal 1996b).

Other rust fungi reported on *Anaphalis* spp. include *Miyagia anaphalidis* Miyabe on *A. acutifolia*, *A. aureopunctata*, *A. brevifolia*, *A. hancockii*, *A. margaritacea* subsp. *angustior*, *A. margaritacea* subsp. *japonica*, *A. margaritacea* subsp. *yedoensis*, *A. morrisonicola*, *A. sinica*, *A. subdecurrens*, *A. yedoensis*, and *A. zeylanica* from Japan, China, Sri Lanka, and Taiwan; *Miyagia macrospora* Hirats. f. on *A. aureopunctata*, *A. contorta*, *A. morrisonicola*, *A. nepalensis*, and *A. xylorhiza* from China, Nepal, and Taiwan; *Phakopsora artemisiae* Hirats. on



FIGS. E–H: *Puccinia anaphalidis-virgatae* (E). Aeciospores showing germ pores (F). Peridial cells of the aecidia (G). Urediniospores showing germ pores (H). Teliospores
Scale bar for E & G = 10 μ m, F = 5 μ m, H = 15 μ m.

A. margaritacea, and *A. sinica* from China and Nepal; *Phakopsora compositarum* T. Miyake on *A. sinica* from China; *Phakopsora elephantopi* Hirats. on *A. sinica* from China; *Uromyces amoenus* Syd. & P. Syd. on *A. alpicola*, *A. busua*, *A. contorta*, and *A. margaritacea* from China, Japan and Nepal; and *Uromyces langtangensis* Durrieu on *A. nepalensis* from Nepal (Sawada 1943, Ito 1950, Hiratsuka 1969, Hiratsuka 1973, Tai 1979, Azbukina 1984, Durrieu 1987, Guo 1989, Ono et al. 1990, Hiratsuka & Chen 1991, Hiratsuka et al. 1992, Zhuang 1993, Zhuang & Wei 1994, Gjaerum 1995, Khalid & Iqbal 1996a,b, Cao et al. 2000, Zhuang 2005).

Puccinia anaphalidis-virgatae is characterized by the absence of peridia in uredinia and telia and up to 6 scattered germ pores in urediniospores. Another characteristic feature is the presence of thickened, rounded, or conical apices of the teliospores with persistent pedicels.

Species in the genus *Miyagia* have peridiate uredinia and telia while the absence of peridial uredinia and telia is characteristic of the genus *Puccinia* (Cummins & Hiratsuka 2003). The uredinia and telia of *Miyagia anaphalidis* are peridiate with a peridium of laterally adherent, palisade-like paraphyses.

Moreover, aecia of *Miyagia* are erumpent and uredinioid with aeciospores borne singly on pedicels. The aecia of *P. anaphalidis-virgatae* are of the aecidium type with a peridium. *Miyagia anaphalidis* is somewhat comparable to the *P. anaphalidis-virgatae* in the size and wall ornamentation of the urediniospores and teliospores. *Puccinia anaphalidis-virgatae* with urediniospores having 5–6 scattered germ pores differs from *M. anaphalidis* with 2 equatorial germ pores.

Puccinia anaphalidis-virgatae differs from *P. horti-kirstenboschi* Berndt & E. Uhlmann reported on *Helichrysum* sp. by the size and shape of teliospores. *P. anaphalidis-virgatae* has larger ($20\text{--}26 \times 50\text{--}64$ (–70) μm vs. $17\text{--}23 \times 40\text{--}55$ μm) teliospores with thicker ($5\text{--}10$ μm vs. $0.5\text{--}1.5$ μm) apices than in *P. horti-kirstenboschi*.

P. anaphalidis-virgatae is similar to *P. subindumentana* Berndt reported on *Helichrysum chrysophorum* by the shape and apical thickness of teliospores. However, aeciospores are smaller ($19\text{--}22 \times 21\text{--}29$ μm vs. $25\text{--}30 \times 27\text{--}33$ μm) and teliospores are wider ($20\text{--}26$ μm vs. $16\text{--}22.5$ μm) with a persistent pedicel. *P. anaphalidis-virgatae* has smaller aeciospores ($19\text{--}22 \times 21\text{--}29$ μm vs. $23\text{--}31 \times 29\text{--}41$ μm) and urediniospores ($17\text{--}24 \times 20\text{--}28$ μm vs. $24.5\text{--}29.5 \times 28\text{--}34.5$ μm) than in *P. cornurediata* Berndt reported on *Helichrysum petiolatum* D. Don. Moreover, *P. anaphalidis-virgatae* lacks peridia in uredinia while *P. cornurediata* possesses slightly tapering, orange-yellow peridium in uredinia.

***Puccinia helictotrichi* var. *pakistanica* Afshan & Khalid, var. nov.**

FIGS. I–J

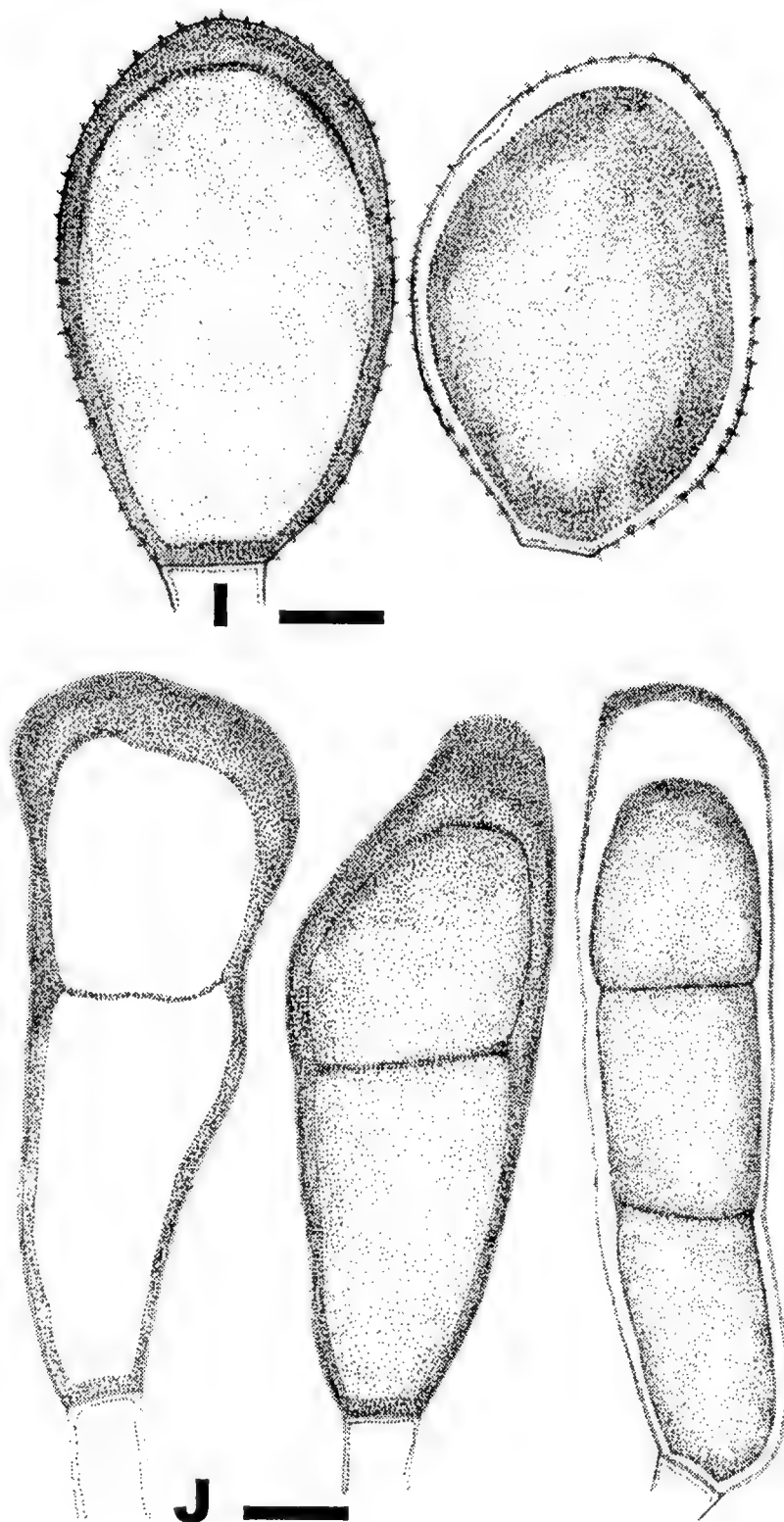
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Spermogonia et aecia ignota. Uredinia amphigena, subepidermalia. Urediniosporae globosae vel subglobosae, ovoidae vel ellipsoideae, $19\text{--}25 \times 23\text{--}29$ (–32) μm ; pariete $1\text{--}1.5$ μm crasso, pallide brunneo vel brunnea, echinulato; poris germinationis 2–4, aequatorialibus vel supra-aequatorialibus. Telia amphigena, subepidermalia, atra. Teliosporae 1–3-cellulares, oblongae vel clavatae, $14\text{--}21 \times (36\text{--})44\text{--}56$ μm , pariete levi, $1.5\text{--}2$ μm crassa, ad apicem $4\text{--}7$ μm crasso, cinnamomea vel atro-brunneo, basaliter pallidae; apice truncato vel obtuso; pedicellis hyalino vel dilute brunneis, $5\text{--}8 \times 11\text{--}14$ μm .

HOLOTYPE: On *Helictotrichon virescens* (Nees ex Steud.) Henrard (*Poaceae*), II + III stages, Pakistan, Northern Areas, Fairy Meadows, 3036 m a.s.l., 12 Aug 2007. NSA # 69. (LAH - NSA 1075).

ETYMOLOGY: Named after the country, Pakistan.

SPERMOGONIA and **AECIA** unknown. **UREDINIA** amphigenous, subepidermal, yellowish brown to golden brown, $0.09\text{--}0.1 \times 0.1\text{--}2.0$ mm. **UREDINIOSPORES** globose to subglobose or ovoid to ellipsoid, $19\text{--}25 \times 23\text{--}29$ (–32) μm ; wall $1\text{--}1.5$ μm thick, pale brown to cinnamon brown, echinulate; germ pores 2–4, equatorial to supraequatorial, pedicel hyaline, $4\text{--}6$ μm wide and up to 16 μm long. **TELIA** amphigenous, covered by epidermis, dark brown to blackish brown, loculate with paraphyses, $0.09\text{--}0.5 \times 0.2\text{--}0.8$ mm. **TELIOSPORES** 1–3-



FIGS. I–J: *Puccinia helictotrichi* var. *pakistanica*
(I) Echinulate urediniospores. (J) Teliospores. Scale bar = 10 μm .

celled, oblong to clavate, septa usually horizontal, but sometimes oblique in three-celled spores, $14\text{--}21 \times (36\text{--})44\text{--}56 \mu\text{m}$ (mean $17 \times 44 \mu\text{m}$); wall $1.5\text{--}2 \mu\text{m}$ thick, cinnamon brown to golden brown but paler basally, smooth; apex mostly truncate, sometimes rounded, $4\text{--}7 \mu\text{m}$ thick; germ pores obscure; pedicel hyaline to pale brown, $5\text{--}8 \times 11\text{--}14 \mu\text{m}$.

COMMENTS: *Puccinia helictotrichi* var. *pakistanica* is characterized by the presence of 1–3-celled teliospores with sometimes oblique septa in three-celled spores. The presence of 2–4 equatorial germ pores in urediniospores and the absence of uredinial paraphyses also make it different from other *Puccinia* species reported on hosts in the same tribe.

Puccinia helictotrichi var. *pakistanica* closely resembles *P. helictotrichi* Jørst. by the shape and wall ornamentation of urediniospores and size of teliospores. These varieties can be separated by the size of urediniospores. *P. helictotrichi* var. *pakistanica* has smaller urediniospores ($19\text{--}25 \times 23\text{--}29$ ($\text{--}32$) μm vs. $18\text{--}26 \times 24\text{--}48$ μm) than *P. helictotrichi*. Another characteristic difference is the presence of 1–3-celled teliospores with thicker apices ($4\text{--}7$ μm vs. $2\text{--}4$ μm) and 2–4 equatorial germ pores of urediniospores in the *P. helictotrichi* var. *pakistanica* than in *P. helictotrichi* that possesses 1–2 celled teliospores with 6–12 scattered, obscure germ pores.

Puccinia helictotrichi var. *pakistanica* is similar to *P. brachypodii* var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene in the shape, wall ornamentation, and size of urediniospores. These species differ in the size of teliospores, which are smaller in *P. helictotrichi* var. *pakistanica* ($14\text{--}21 \times (36\text{--}) 44\text{--}56$ μm vs. $12\text{--}27 \times 30\text{--}80$ μm). The presence of 1–3-celled teliospores, sometimes with a vertical septum in three-celled teliospores and absence of uredinial paraphyses in *P. helictotrichi* var. *pakistanica* make it different from *P. brachypodii* var. *poae-nemoralis*.

On the basis of close resemblance with *P. helictotrichi*, this species is described as a new variety of *P. helictotrichi* i.e. *P. helictotrichi* var. *pakistanica*.

Acknowledgments

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Literature cited

- Afshan NS, Khalid AN, Iqbal SH, Niazi AR, Sultan A. 2009. *Puccinia subepidermalis* sp. nov. and new records of rust fungi from Fairy Meadows, Northern Pakistan. *Mycotaxon* 110: 173–182.
- Azbukina ZM. 1984. Key to the rust fungi of the Soviet Far East. Akademiya Nauk SSSR, Moscow. 286 p.
- Cao ZM, Li ZQ, Zhuang JY. 2000. *Uredinales* from the Qinling Mountains (continued I). *Mycosystema* 19: 181–192.

- Cummins GB, Hiratsuka Y. 2003. Illustrated Genera of Rust Fungi. Third ed. The American Phytopathological Society. APS Press, St. Paul, MN.
- Durrieu G. 1987. *Uredinales* from Nepal. Mycologia 79: 90–96.
- Gjaerum HB. 1995. Rust fungi from various countries. Lidia 3: 145–170.
- Guo L. 1989. [*Uredinales* of Shennongjia, China]. Fungi & Lichens Shennongjia, pp. 107–156.
- Hiratsuka N. 1969. Notes on the genus *Miyagia* Miyabe ex Sydow. Trans. Mycol. Soc. Japan, 10: 89–90.
- Hiratsuka N, Chen ZC. 1991. A list of *Uredinales* collected from Taiwan. Trans. Mycol. Soc. Japan 32: 3–22.
- Hiratsuka N, Sato S, Katsuya K, Kakishima M, Hiratsuka Y, Kaneko S, Ono Y, Sato T, Harada Y, Hiratsuka T, Nakayama K. 1992. The Rust Flora of Japan. Tsukuba Shuppankai, Tsukuba.
- Hiratsuka Y. 1973. The nuclear cycle and the terminology of spore states in *Uredinales*. Mycologia 65: 432–443.
- Iqbal SH, Afshan NS, Khalid AN, Niazi AR, Sultan A. 2009. Additions to the rust fungi of Fairy Meadows, the Northern Areas of Pakistan. Mycotaxon 109: 1–7.
- Ito S. 1950. Mycological Flora of Japan. Vol. II. Basidiomycetes. No. 3. *Uredinales – Pucciniaceae. Uredinales* Imperfecti. Yokendo Ltd., Tokyo. 435 p.
- Khalid AN, Iqbal SH. 1996a. Additions to the rust flora of Pakistan. Pakistan Journal of Botany 28(1): 114–117.
- Khalid AN, Iqbal SH. 1996b. New rusts from Pakistan. Canadian Journal of Botany 74: 506–508.
- Ono Y, Adhikari MK, Rajbhandari K. 1990. *Uredinales* of Nepal. Rep. Tottori Mycol. Inst. 28: 57–75.
- Sawada K. 1943. Descriptive catalogue of the Formosan fungi. Part IX. Rep. Dept. Agric. Gov. Res. Inst. Formosa, 86: 1–178.
- Tai FL. 1979. Sylloge Fungorum Sinicorum. Sci. Press, Acad. Sin., Peking. 1527 p.
- Zhuang JY. 1993. Further data on the genus *Uromyces* of China. Mycosystema 6: 31–37.
- Zhuang JY, Wei SX. 1994. An annotated checklist of rust fungi from the Mt. Qomolangma region (Tibetan Everest Himalaya). Mycosystema 7: 37–87.
- Zhuang WY. 2005. Fungi of Northwestern China. Mycotaxon, Ltd., Ithaca, NY. 430 p.

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BOOK REVIEWS AND NOTICES

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INTRODUCTION

This installment of BOOK REVIEWS AND NOTICES focuses on two different topics, ascomycetes in different parts of the world, and mushroom guide books from North America. A checklist of the non-lichenized species occurring in Sweden (free to download from the author's web site) and several books on taxonomically or ecologically defined lichen groups are treated in the first part, followed by the review of field oriented guides. The present selection of guides covers the southeast, the northwest, the northern plains in between, the oak associated mycoflora of the eastern U.S.A., and the genus *Lactarius*. The books are as different in layout, user friendliness, and approach as their subjects. Guides are the ideal medium to familiarize amateur mycologists with the huge changes that have recently taken place in the classification of fungi. But the main purposes are to provide accurate names and especially to introduce non-mycologists to the diversity and beauty of this fascinating group of organisms.

A list of recently published books to be included in future reviews is given at the end.

ASCOMYCETES

The non-lichenized Ascomycetes of Sweden. By O.E. Eriksson. 2009. Department of Ecology and Environmental Science, Umeå University, SE-901 87, Umeå, Sweden. <ove.eriksson@emg.umu.se>. Pp. 461, maps 1. ISBN 978-91-7264-989-2. Price not indicated; free for download at <http://www8.umu.se/myconet/asco/asco_pdfs/indexPDF.html>

¹ Books for consideration for coverage in this column should be mailed to the Book Review Editor at the address above. All unsigned entries are by the Book Review Editor.

While the non-lichenized pyrenomycetes and the lichenized fungi known from Sweden have been summarized in relatively recent checklists (Eriksson 1992, Santesson et al. 2004), no overall listing of the phylum has been appeared since that of Fries (1849), something Nannfeldt (1936) commented was a “deplorable state” over 70 years ago. This new checklist remedies this situation, covering all non-lichenized ascomycetes except lichenicolous genera (unless they also include non-lichenicolous species; others being covered in Santesson et al. 2004) and yeasts. It enumerates 2692 species placed in 772 genera and dispersed through 159 families. The genera are, thankfully, all treated alphabetically, but a synopsis by subphylum, class, order, and family is provided at the start. By each generic name, the family placement is indicated, and there is also a letter to indicate the type of spore-bearing structure (e.g. “D” for discomycetes). For each species, information is included in the categories of synonyms, citations in the works of Fries, references to literature, exsiccate citations, host or habitat, distribution (by provinces, or for new records with specimen details), anamorph, and notes. No new scientific names are introduced in the work.

The notes section often includes important and new information or corrections relating to bibliography, nomenclature, or taxonomy — for instance the retention of *Trichothyria* as distinct from *Lichenopeltella*, as *T. alpestris* has setae with a furrow not seen in *Lichenopeltella* species. Detailed notes are provided on 112 “Excluded species” (pp. 297-306), some of which will require more work to resolve conclusively. The bibliography is most impressive at 53 pages and will be an immediate source of elusive references for workers on these fungi. The work ends with a massive 99-page epithet-index to both accepted names and synonyms. One thing that is missing here, however, and which was an especially useful feature of Eriksson’s earlier pyrenomycete checklist, is a listing of species by their host organisms; that would add enormous value to any future edition, but at least Eriksson (1992) can be consulted for such information on the pyrenocarpous representatives. I would also have included the dates of publication of at least all the accepted names, as in the British checklist (Cannon et al. 1985), but appreciate that would have involved much additional work and that this can now be obtained at no cost from the *Index Fungorum* website if required.

The work has, characteristically, been meticulously prepared and involved much scouring of not only publications but also herbaria. But that does not mean that there are no slips, as is always inevitable in such a fact-packed work. I will not make any enumeration here, but as it concerns a subheading I do point out that it should be “Subphylum” not “Subclass” before *Pezizomycotina* on p. 7. Additionally, author citations of species names are given for infraspecific taxa other than those including the type, which is contrary to the practice in the CODE (e.g. the “Lib.” should have been omitted in “*Acrospermum graminum*”).

Lib. var. *decipiens* (Pass.) O.E. Erikss.” on p. 21). Corrections and updates are already being reported on the web pages devoted to the project (<<http://www8.umu.se/myconet/asco/indexASCO.html>>).

Today, fungi with no known sexual structures can be placed by molecular phylogenetic methods within the ascomycete system based on the sexual stages. This means that in the future such phylum-based checklists should logically include the hordes of fungi known only in the mitosporic state. This would involve a major expansion of ascomycete checklists in the future, and here Eriksson has, as a matter of policy, included only taxa represented by the teleomorph in Sweden — with the exception of members of *Erysiphales* “where we can expect that the teleomorph will be found” (p. 4). The names of anamorphs for species found forming teleomorphs in the country are, however, provided as noted above.

Although this list may seem enormous in comparison with the checklists for non-lichenized ascomycetes in many other countries, it constitutes a huge stride towards the elusive goal of a full national inventory. It is now **the** key reference work for anyone concerned with non-lichenized ascomycetes in Sweden, and all ascomycologists and conservationists should be indebted to Ove for the herculean effort he has put in bringing this task to publication.

Cannon PF, Hawksworth DL, Sherwood-Pike MA. 1985. The British *Ascomycotina*: an annotated checklist. Slough: Commonwealth Agricultural Bureaux.

Eriksson OE. 1992. The non-lichenized Pyrenomycetes of Sweden. Lund: SBT-förlaget.

Fries EM. 1849. Summa Vegetabilium Scandinaviae. Vol. 2. Stockholm: A. Bonnier.

Nannfeldt JA. 1936. Contributions to the mycoflora of Sweden 3. Some rare or interesting inoperculate discomycetes. Svensk Botanisk Tidskrift 30: 285-306.

Santesson R, Moberg R, Nordin A, Tønsberg T, Vitikainen O. 2004. Lichen-forming and lichenicolous fungi of Fennoscandia. Uppsala: Museum of Evolution, Uppsala University.

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Lichens. By H. Thüs & M. Schultz. 2009. Spektrum Akademischer Verlag, Tiergartenstraße 17, 69121 Heidelberg, Germany. <scsc-books@springer.com>. Pp. 209, plates 6, figs 171. Süßwasserflora von Mitteleuropa. Vol. 21. *Fungi*. Part 1. ISBN 978-3-8274-1594-3. Price: € 64.95, CHF 94.50.

This series, eventually comprising 24 volumes, some with several separately bound parts, aims to cover the freshwater “flora” of Central Europe. It is a classic reference work for algologists, with 19 of the volumes dealing with different algal and cyanobacterial groups. It is pleasing to see lichens included in this prestigious work, and especially as they appear as the first part in the volume on “*Fungi*”. The book aims to be a tool for the identification of all

freshwater lichens occurring in Central Europe, and the introduction notes the categories of aquatic (able to survive under water for more than a year), amphibian (occurring in splash zones), riparian (living close to, but never in, water), and terrestrial (with a low tolerance of submersion). Ecological factors affecting occurrences are outlined, including pH, nutrients, and sediments, but somewhat surprisingly nothing on zonation patterns or the use of lichens in assessments of river capacities. Following a clearly presented glossary, there is a “General key” which, in addition to the genera treated, includes 23 lichens that are not — notably in the genera *Catillaria*, *Lecanora*, and *Physcia*. The main body of the work, however, comprises “keys to species and species profiles”. Thirty-six genera are treated alphabetically, pyrenocarpous ones predominating, with *Thelidium* and *Verrucaria* as the most speciose genera with 18 and 24 species respectively. The latest generic concepts are employed, with, for example, the acceptance of *Hydropunctaria* and *Sporodictyon*.

Each generic account cites the pertinent literature followed by sometimes extensive discussion on status or circumscription, followed by a key to the treated species. As in the “General key”, species not accorded separate entries are sometimes included in these keys. For each species there is information on synonyms, a description, notes on ecology and distribution, and most importantly notes on separations from other similar species. In a few instances “s.l.” is used to embrace groups of closely allied and difficult to separate species (e.g. *Verrucaria margacea* s.l.). Author citations of scientific names are given with the year of publications throughout, whether accepted names or synonyms — an increasing practice that merits general adoption. There are schematic diagrams of sections of vertical sections of perithecia in some genera and fine half-tone macro-photographs showing the habit of the species as they would be seen in the field with a hand lens. The half-tones are supplemented by six colour plates at the end of the book — more use of colour should be considered for any future edition. The collection details of all figured specimens are included, together with an indication of the herbarium in which they are preserved — something too often missing in illustrated guides.

The book is authoritative, comprehensive, pocket-sized, strongly bound, and entirely in English. Also, while focussed on central Europe, it must be pointed out that many of the taxa have wide distributions in Mediterranean, western, and northern Europe in particular, as well as other continents. This work consequently has the potential to generate a renewed interest in the so often neglected freshwater lichens not only by lichenologists, but further by ecologists freshwater biologists, and geographers internationally.

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Taxonomical Revision of the *Caloplaca saxicola* group (*Teloschistaceae*, lichen-forming fungi). By E. Gaya. 2009. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstraße 3A, 70176 Stuttgart, Germany. <mail@schweizerbart.de>. Pp. 191, plates 36 (5 col.), figs 2. Bibliotheca Lichenologica No. 101. ISBN 978-3-443-58080-3. Price: € 73.00.

This has been a taxonomically confusing group, with great uncertainty over the application of names, and so this worldwide revision was much needed. The group comprises saxicolous species that are lobate-effigurate and have ellipsoid ascospores with a median septum at least 3 µm thick. The “group” is restricted to a smaller core to exclude *Caloplaca cirrochroa*, *C. marina*, *C. microthallina*, *C. scopularis*, *C. verruculifera*, etc. The characters employed in the differentiation of the taxa are described in detail, with in-depth accounts of thallus features and tissue types, as well as of exciple types, paraphyses, ascospores, and conidia. In the *C. saxicola* group itself, eleven species and five subspecies are recognized, and a further ten species considered as closely related are also treated in detail (incl. *C. aurantia*, *C. flavescens*, *C. thallincola*, and sorediate species). For each species information is provided on synonyms, types, in some cases a transcription of the original diagnosis, illustrations, distribution, ecology, specimens examined, and there are particularly full descriptions and discussions (under “Remarks”). The microscopic features of each accepted species are shown in one or more full-pages of line drawings, and macroscopic appearances of the thalli are illustrated in a series of coloured plates. The colour is especially valuable here, as the nuances of oranges and yellows can aid species recognition in these lichens. Something I did miss was any photomicrographs of sections to show the different tissue structures of the cortices and the exciple types to help relate the necessarily somewhat schematic line drawings to what is actually seen in the microscope. The revision is based entirely on morphological and anatomical features, to some extent supported by principal component analyses, and no molecular data in support of the revised taxonomy are presented. This carefully executed work will need to be taken into account in re-assessing which taxa are actually present and which names have been wrongly used, in national and regional checklists. For example, *C. arnoldii* of UK authors is *C. arnoldii* subsp. *obliterata*, and *C. saxicola* includes *C. murorum*; the name *C. saxicola* is to be proposed for conservation. This may not be the last word on the group, especially as more material from Asia and the Southern Hemisphere becomes available and the concepts merit challenging by molecular phylogenetic approaches, but it represents a major step forward.

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Revision of the corticolous *Opegrapha* species from the Palaeotropics.

By D. Ertz. 2009. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstraße 3A, 70176 Stuttgart, Germany. <mail@schweizerbart.de>. Pp. 176, figs 124. Bibliotheca Lichenologica No. 102. ISBN 978-3-443-58081-0. Price: € 73.00.

A major obstacle to getting to grips with crustose lichens in tropical countries has been the lack of authoritative revisions. Reassessments are needed of the thousands of names introduced in the nineteenth century, often published with the briefest of diagnoses and no illustrations. Good progress to that end has been made with graphids, thelotremes, and some pyrenocarpous groups, and here *Opegrapha* species on trees or wood are tackled. But this work does not only deal with palaeotropical material from the past (from tropical Africa, Asia, and Australia), it is also based on collections made by the author in Benin, Gabon, La Réunion, Rwanda, and Zambia. In all, 52 species are accepted, of which seven are tentatively (and responsibly) named using “aff.”, eight are described as new to science, and two proved to be lichenicolous; 31 names are newly recognized as synonyms; six species were found to belong in other genera (notably *Arthonia*, *Enterographa*, *Lecanographa*, and *Patellaria*); and nine names are categorized as doubtful or otherwise excluded. A staggering 17 generic names are listed as synonyms of *Opegrapha*. There is a user-friendly key based on the artificial but pragmatic categories of spore septation, but no attempt to discuss phylogenetic relationships within these species or the genus as a whole. For each accepted species, there is the expected information on synonyms and types, detailed descriptions; notes on chemistry, ecology, and distribution; highly pertinent “observations”; and lists of additional specimens examined. The accompanying illustrations comprise photomicrographs showing the habit and details of the lirellae, line drawings of asci and ascospores; and maps of the known world distributions. Photomicrographs of vertical sections of the lirellae, showing details of the excipular structures, would have added value. Damien is to be congratulated on yet another meticulously executed contribution to his elucidations of opegraphoid lichens, and in this case one which also forms a base-line for further exploration and identification of existing collections from the Palaeotropics. A companion work to tie these results into the taxa described from the Neotropics would now be most welcome.

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Porosty pięrea kosodrzewiny w Polskiej części Tatr Wysokich. By M. Węgrzyn.

2009. Instytut Botanik im. W. Szafera, Polska Akademia Nauk, ul. Lubicz 46, 31-512 Kraków, Poland. <l.frey@botany.pl>. Pp. 117, figs 10, maps 224. ISBN 978-83-89648-64-8. Price: € 25.00.

This is an account of the lichens of the dwarf pine (*Pinus mugo*) belt of the Polish part of the High Tatra Mountains, which occurs at an altitude of around 1550-1800 m. Forty eight sites were examined, which yielded a total of 225 lichens and five lichenicolous fungi — roughly 25% of all the lichen species known from the Polish Tatra Mountains as a whole. For each species, information on the ecology and sites in which they were found is presented. Most species are characterized as alpine, with a few subalpine and many “multizonal” species. However, in the locality data presented, many of the species occurred in only 1-3 sites and 64% were categorized as “very rare”. Indeed, 89 species were ones classified as “vulnerable or endangered”, and 13 as “critically endangered” in Poland as a whole; the latter include *Bryoria implexa*, *Catolechia wahlenbergii*, *Evernia divaricata*, *Hypogymnia vittata*, and *Solorina crocea*. Some of the results were somewhat surprising to me, for example a single occurrence of *Xanthoria parietina*, and also only one of *Alectoria sarmentosa* as opposed to ten of *A. ochroleuca* (the reverse of the situation on the high Scottish mountains). Distribution maps are provided for all but one of the lichen species. The area had not been given much attention by lichenologists since Motyka dismissed it as very poor in lichens in the mid-1920s, but it clearly is a site of conservation importance with so many species that are rare or endangered in Poland today. Although in Polish, there is a welcome one-page summary in English, and the legends to the tables and figures are also given in both languages. This is clearly a carefully executed study, and one that will provide a baseline against which to monitor any of the future changes that might be expected to occur as a result of climate change.

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GUIDES

Macrofungi associated with oaks of eastern North America. By D.E. Binion, S.L. Stephenson, W.C. Roody, H.H. Burdsall, Jr, L.N. Vasilyeva & O.K. Miller, Jr. 2008. West Virginia University Press, PO Box 6295, Morgantown, WV 26506, U.S.A. <press@wvu.edu>. Pp. xv + 467, plates. ISBN 978-1-933202-36-5. Price \$44.95.

Not the shape of the mushrooms, but their ecology is the main organizer of this guidebook in which macrofungi associated with oaks in the eastern parts of North America (without Mexico) are treated. After a short introduction to the oak habitat and fungi in general, mushrooms are shown in three sections (mycorrhizal fungi, parasites, and decomposers). Over 200 species are treated, each one on two pages with a photo on the left and the text on the right. A short

list of references and tips for further reading, a glossary, and a short chapter on mushroom poisons follow at the end of the book. There are no keys to the species that are treated. The photos are in general of very good quality (a few are out of focus), the names are usually up to date, and attention has been paid to details, such as the names of the authors of the species. Data on habitat and distribution are a little too scant, and in some cases wrong; e.g. *Tremella* is put in with the decomposers, though it parasitizes other fungi.

It is refreshing to see so many polypores and crust fungi in a 'mushroom' guide! The rare species *Globifomes graveolens* and *Porodisculus pendulus* are well illustrated, together with their more common relatives. The mycorrhizal life style of some of some of the crust-forming species might come as a surprise to the users. Determining which lifestyle your fungus has may be difficult, but by flipping through the pages you get a lot of extra knowledge from this heavy book.

In short, a well-executed, interesting, and well-illustrated book.

Mushrooms and other fungi of the midcontinental United States. (Bur Oak Guide). 2nd Ed. By D.M. Huffman, L.H. Tiffany, G. Knaphus & R.A. Healy. 2008. University of Iowa Press, 119 W. Park Road, 100 Kuhl House, Iowa City, IA 52242-1000, U.S.A. <uiopress@uiowa.edu>. Pp. 384, plates 300, figs 21. ISBN 978-1-58729-627-7. Price \$39.95.

This is the second edition of a guide to the mushrooms of Iowa, with more species (especially ascomycete truffles) covered and some photographs replaced. This book has the usual set up of an introduction to mushrooms, a subdivision into larger groups (e.g., *Agaricales*, *Boletales*, *Aphyllophorales*, gasteromycetes, jelly fungi, and ascomycetes) with species treated alphabetically and — within the *Agaricales* — further subdivided according to family. A glossary, and lists of general and technical references complete the book. The layout is clear, with photos on the left page and (short) descriptions on the right, usually with two species on a page. Keys to the around 300 species that are treated in the book are also given.

Some photos are very good, but some of the older ones are too dark with colours too inaccurate for identification purposes. Additionally, some names do not seem plausible. As is common in most guides, the source for the photos and descriptions is not given.

Names have been updated in some cases (e.g. *Microstoma floccosum* replaces *Sarcoscypha floccosa* of the first edition), but *Hygrophorus* has been retained for species that are now universally accommodated in *Hygrocybe*, the family *Lepiotaceae* no longer exists, nor is there any longer an order 'Aphyllophorales' or the equally artificial 'Gasteromycetes'.

Nevertheless, this remains a nice first introduction to the fungi of this midcontinental state, where forests and mushroom guides are not very common.

Mushrooms of the Pacific Northwest. Timber Press Field Guide. By S. Trudell & J. Ammirati. 2009. Timber Press, 133 SW 2nd Avenue #450, Portland, OR 97204, U.S.A. <info@timberpress.com>. Pp 352, plates 530, figs 22. ISBN 9780881929355. Price \$27.95.

This book is like a whiff of fresh air in mushroom field guide land. It clearly states the geographical area that it covers, the introduction tells about the life styles of mushrooms, the hazards and pleasures of mushroom hunting, the pit falls of identification keys, and of course poisonings and much more. The bulk of the book is taken up by photos and descriptions of mushrooms. Spore print colour codes the top of the page; the descriptions are informative and well written (not in telegraph style), and for many photos a collection number is given, so the names can be verified. The emphasis is not on the charismatic megafunga, although certainly big mushrooms are treated, but the less conspicuous fruitbodies feature prominently. Names are generally up-to-date, and author names are consistently spelled in the same way. Names also seem correct and to fit the pictures. The only negative comment I can make is that the photos are a little on the small side; making them bigger would have increased the price of the book significantly. The book is slightly too big and too beautiful to be taken out into the field, but it would definitely like to live in your car, for the after-the-hunt identification spell. The price is also extremely reasonable, and this book deserves to be used all through the western states.

Mushrooms of the southeastern United States. By A.E. Bessette, W.C. Roody, A.R. Bessette & D.L. Dunaway. 2007. Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, NY 13244-5290, U.S.A. <supress@syr.edu>. Pp. 400, plates 527. ISBN 978-0-8156-3112-5. Price \$95.00.

The southeastern parts of the U.S.A. are well known for their plant and fungal diversity, but field guides to the latter are rare and cover only parts of this hugely diverse area. The present book by Bessette et al. fills this gap and aims at illustrating and describing over 450 species from various fungal groups forming macroscopic basidiocarps. Field characteristics are emphasized in the keys and descriptions. The format is similar to that of the earlier book by Bessette et al. (1997) that covers the northeastern parts of the U.S.A.: all plates with 6 figures per page cluster together, followed by all descriptions. All are organized alphabetically by group, and the groups are morphologically recognized (in other words, not phylogenetically). The introduction to mycology and a glossary will be helpful for the mycological novice. There are

two sections of references, one with technical literature, the other with so-called non-technical publications. Four appendices, with scant information on microscopic examination of mushrooms, chemical reagents used in mushroom identification, classification, and mycophagy (including recipes and photos of tempting dishes) complete the book.

The guide gives a good first introduction to the mushroom flora of the area, with the emphasis on the larger and showier species. It is very nice to see a good selection of subtropical polypores depicted. However, there are many shortcomings in the details.

It is not at all clear where the descriptions come from. The authors claim that they are based on the original descriptions. This is in many cases not true (e.g. the original description of *Leucocoprinus cepistipes* does not fit the present interpretation of the species and is extremely unspecific). The second problem is that there is no specified information on the photos — in the ideal situation descriptions should be based on the material depicted, which has been vouchered and is available for further study in a publicly accessible herbarium. Field guides are in particular an excellent venue to make the amateur mycologists aware and familiar with the large changes happening in our understanding of the fungal phylogenies and consequently in classifications. Unfortunately, the argument that all is in flux has been applied, resulting in no changes at all. Two examples: the genus *Paxillus* still harbours both *P. involutus* and *P. atrotomentosus*, although the latter, a non-mycorrhizal species, has long been accepted in *Tapinella*; likewise, *Omphalotus illudens* is called *O. olearius*, which is a strictly European species. The nomenclature and author citations are appalling, as if there are no easily accessible on-line data files available.

In conclusion, this book gets a mixed report — beautiful well-photographed mushrooms make up for the mistakes in the details and the outdated nomenclature.

Bessette AE, Bessette AR, Fischer DW, 1997. Mushrooms of northeastern North America. Syracuse University Press.

Milk mushrooms of North America. A field identification guide to the genus *Lactarius*. By A.E. Bessette, D.B. Harris & A.R. Bessette. 2009. Syracuse University Press, 621 Skytop Road, Suite 110, Syracuse, NY 13244-5290, U.S.A. <supress@syr.edu>. Pp. 256, plates 263. ISBN 978-0-8156-3229-0. Price \$110.00.

Though not really a field guide, this treatment of the genus *Lactarius* for North America (excluding Mexico) has that feel, as it does not cover microscopic characters, and the keys and descriptions of *Lactarius* species are written in language that should be clear for a beginning amateur. Besides the genus *Lactarius*, a few species from related genera *Zelleromyces*, *Bondarzewia*,

Arcangeliella, and two fungal parasites of *Lactarius* species are illustrated and provided with descriptions. An introduction to the characters of the genus, the edibility, ecology, and field characters lay the basis for the bulk of the book. Dichotomous keys treat the species divided by region (western species vs eastern species). The plates are grouped together with 3 figures per page, and are organized alphabetically by species, often with multiple photos per species to show the colour variation (unfortunately it is not often clear whether the colour variation is in the mushroom or due to the photo). The descriptions are also alphabetical. Approximately two-thirds of the species are represented by a colour photo. Source information is not given for the photos or the descriptions, nor is there an indication whether the photos are connected to the descriptions. The authors are most familiar with the northeastern species, and the ecology and distribution of the western species are scantily covered. More attention could have been paid to the details, such as the references and the author names for each species. Recent literature and developments in *Lactarius* classification have not been incorporated in this book, unfortunately. Future research will probably result in the rejection of many of the European names that are applied to American species. The book serves perfectly as a colour guide to the much more technical and out-of-print work by Hesler & Smith (1979), but it falls short of being a critical assessment of the genus in North America. Last but not least, the price will be a severe impediment for wide usage of this book.

Hesler LR, Smith AH, 1979. North American species of *Lactarius*. The University of Michigan Press, Ann Arbor.

BOOK ANNOUNCEMENTS

***Agaricus* L. *Allopsalliota* Nauta & Bas. *Fungi Europaei* 1. 2nd Ed. By L. A. Parra Sánchez. 2008. Edizioni Candusso, Via Ottone Primo 90, 17021 Alassio SV, Italy. <maxcandusso@libero.it>. Pp. 824, Plates 396 + 42, figs 114. ISBN 88-901057-7-1. Price € 75.00.**

Compléments à la Flore des champignons supérieurs du Maroc de G. Malençon et R. Bertault. By J.-C. Maire, P.-A. Moreau, G. Robich (editors). 2009. Confédération européenne de mycologie méditerranéenne, Nice. Pp. 775, plates 58, figs 50. No ISBN number. Price ca. € 116.00.

Common interior Alaska cryptogams. Fungi, lichenicolous fungi, lichenized fungi, slime molds, mosses, and liverworts. By G.A. Laursen & R.D. Seppelt. 2009. University of Alaska Press, PO Box 756240, Fairbanks, AK 99775, U.S.A. <fyppress@uaf.edu> Pp. 256, plates 338, figs 113. ISBN 9781602230583. Price \$26.95.

Conocybe Fayod. Pholiotina Fayod. Fungi Europaei 11. By A. Hausknecht. 2009. Edizioni Candusso, Via Ottone Primo 90, 17021 Alassio SV, Italy. <maxcandusso@libero.it>. Pp. 968, plates 46 + 403, figs 150, maps 154. ISBN 88-901057-8-X. Price € 79.00.

Edible wild mushrooms of Illinois and surrounding states: A field-to-kitchen guide. By J. McFarland & G.M. Mueller. 2009. University of Illinois Press, University of Illinois Press, 1325 South Oak Street, MC-566, Champaign, IL 61820-6903, U.S.A. <uipress@uillinois.edu>. Pp. 232, plates 292. ISBN 978-0-252-07643-5. Price \$24.95.

Fungi from different environments. By J.K. Misra & S.K. Deshmukh (editors). 2009. Science Publishers, 234 May Street, P.O. Box 699, Enfield, NH 03748, U.S.A. <info@scipub.net>. Pp. 405. ISBN 978-1-57808-578-1. Price \$119.95.

Fungus flora of tropical Africa. Volume 2. Monograph of *Lactarius* in tropical Africa. By A. Verbeken & R. Walley. 2010. National Botanic Garden of Belgium, Nieuwelaan 38, 1860 Meise, Belgium, <sales@br.fgov.be>. Pp. 151, plates 54. ISBN 978-90-726-1981-5. Price € 50.00.

Il genere *Crepidotus* in Europa. By G. Consiglio & L. Setti. 2009. Associazione Micologica Bresadola, Via A. Volta, 46, 38100 Trento, Italy. <amb@ambbresadola.it> Pp. 344, numerous plates, figs. No ISBN number. Price € 50.00 or € 60.00.

The kingdom *Fungi*. The biology of mushrooms, molds and lichens. By S.L. Stephenson. 2010. Timber Press, 133 SW 2nd Avenue #450, Portland, OR 97204, U.S.A. <info@timberpress.com>. Pp. 328, plates 124. ISBN 978-0-88192-891-4. Price \$34.95, £ 20.00.

Notable macrofungi from Brazil's Paraná pine forests. Macrofungo notáveis das florestas de Pinheiro-do-Paraná. By A.A.R. de Meijer. 2009 (2008). Embrapa Informação Tecnológica, Parque Estação Biológica, Caixa Postal 040315, Brasília, DF, Brazil 70770-901. <vendas@sct.embrapa.br>. Pp. 418, plates 102. figs 47. ISBN 978-85-89281-17-1. Price R\$120.00.

Pictorial atlas of soil and seed fungi: Morphologies of cultured fungi and key to species. 3rd Ed. By T. Watanabe. 2010. Routledge, Taylor & Francis Group, 270 Madison Avenue, New York, NY 10016, U.S.A. ISBN 978-1-4398041-9-3. Price \$143.96.

Quelques espèces nouvelles ou mal délimitées d'*Amanita* de la sous-section *Vaginatinae*. 1^o complément à *Amaniteae*, Fungi Europaei 9. By P. Neville † & S. Poumarat. 2009. Fungi non delineati LI-LII. Edizioni Candusso, Via Ottone Primo 90, 17021 Alassio SV, Italy. <maxcandusso@libero.it>. Price € 26.00.

Schimmelpilze und deren Bestimmung. 3. neu bearbeitete Aufl. By L.E. Petrini & O. Petrini. 2010. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Johannesstraße 3A, 70176 Stuttgart, Germany. <mail@schweizerbart.de>. Pp. x + 170, figs 33. ISBN 978-3-443-50035-1. Price € 39.80.

Taxonomic studies on *Agaricales* of Hokkaido, Northern Japan, with special reference to *Melanoleuca*, *Oudemansiella*, *Xerula*, *Volvariella* and *Pluteus*. By S. Takehashi, T. Hoshino & T. Kasuya. 2010. Non profit organization The forum of Fungi in northern Japan, Kanayama 1-3 10-3, Teine-ku, Sapporo, Hokkaido, 006-0041, Japan. <BXG05024@nifty.com>. Available from SANO Books, Sakae-machi 6-19, Aioi-city, Hyogo 678-0008, Japan, <e_sano@d2.dion.ne.jp>. Pp. 145 + xiii, numerous plates, numerous figs. ISBN 978-4-9905010-0-6. Price ¥ 5.600.

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- Castañeda Ruiz, Rafael F., Osmar Morillo, Belkis Tovar, Zulaima Hernández, Teresa Iturriaga, David W. Minter, Josepa Gené, Josep Guarro & Marc Stadler. *Endogenospora*, a new genus of anamorphic fungi from Venezuela. 112: 75–82. 2010.
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- Han, Yanfeng, Jiandong Liang, Zongqi Liang, Xiao Zou & Xuan Dong. Two new *Taifanglania* species identified through DELTA-assisted phenetic analysis. 112: 325–333. 2010.
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- Justo, Alfredo & María Luisa Castro. The genus *Volvariella* in Spain: *V. dunensis* comb. & stat. nov. and observations on *V. earlei*. 112: 261–270. 2010.
- Karandikar, Kedar G. & Sanjay K. Singh. *Lylea indica*: a new hyphomycete species from India. 112: 257–260. 2010.
- Keirle, M.R., P.G. Avis, D.E. Desjardin, D.E. Hemmes & G.M. Mueller. Geographic origins and phylogenetic affinities of the putative Hawaiian endemic *Rhodocollybia laulaha*. 112: 463–473. 2010.
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Rodríguez, Aarón, see Rodríguez & al.

Rodríguez, Olivia, Adrián Galván-Corona, Alma R. Villalobos-Arámbula, Aarón Rodríguez & Laura Guzmán-Dávalos. A new species of *Pluteus* (*Pluteaceae*, *Agaricales*) from Mexico. 112: 163–172. 2010.

Rojas, Thamara, Denisse Caruso, Ninoska Pons & Diego Diamont. Type specimens in the Mycological Herbarium “Albert S. Muller” (VIA), Venezuela. 112: 1–4. 2010.

Romero, Andrea Irene, see Capdet & Romero

Ryoo, Rhim, see Antonín & al.

Saikawa, Masatoshi, see Castañeda Ruiz & al.

Shin, Hyeon-Dong, see Antonín & al.

Shin, Hyeon-Dong, see Han & al.

Silva, B.D.B., see Otoni B.S. & al.

Singh, Avneet P., Priyanka, G.S. Dhingra & Nishi Singla. A new species of *Phlebia* (*Basidiomycetes*) from India. 112: x. 2010.

Singh, Sanjay K., see Karandikar & Singh

Singla, Nishi, see Singh & al.

Sivichai, Somsak & Nattawut Boonyuen. *Jahnula morakotii* sp. nov. and *J. appendiculata* from a peat swamp in Thailand. 112: 475–481. 2010.

Stadler, Marc, see Castañeda Ruiz & al.

- Sultan, A., see Afshan & al.
- Sun, Li-Yan, see Zhang & al.
- Tovar, Belkis, see Castañeda Ruiz & al.
- Vágvölgyi, Csaba, see Nagy & al.
- Vellinga, Else C. (ed.). Book reviews and notices. 112: 491–503. 2010.
- Vellinga, Else C. Lepiotaceous fungi in California, U.S.A. *Leucoagaricus* sect. *Piloselli*. 112: 393–444. 2010.
- Villalobos-Arámbula, Alma R., see Rodríguez & al.
- Vizzini, Alfredo & Marco Contu. *Volvariella acystidiata* (Agaricomycetes, Pluteaceae), an African species new to Europe, with two new combinations in *Volvariella*. 112: 25–29. 2010.
- Wang, Hai-Ying, see Zhang & al.
- Wang, Xin Yu, see Joshi & al.
- Wartchow, Felipe & M. Auxiliadora Q. Cavalcanti. *Lactarius rupestris*—a new species from the Brazilian semi-arid region. 112: 55–63. 2010.
- Wei, T.-Z., see Whalley & al.
- Whalley, A.J.S., see Whalley & al.
- Whalley, M.A., A.M.A. Khalil, T.-Z. Wei, Y.-J. Yao & A.J.S. Whalley. A new species of *Engleromyces* from China, a second species in the genus. 112: 317–323. 2010.
- Wolcan, Silvia M., see Braun & al.
- Yao, Y.-J., see Whalley & al.
- Yurchenko, Eugene, see Hallenberg & al.
- Zhang, Lu-Lu, Hai-Ying Wang, Li-Yan Sun & Zun-Tian Zhao. Four lichens of the genus *Lecidea* from China. 112: 445–450. 2010.
- Zhao, Zun-Tian, see Zhang & al.
- Zhuang, Wen-Ying. Taxonomic assessment of some pyronemataceous fungi from China. 112: 31–46. 2010.
- Zou, Xiao, see Han & al.

ERRATA

VOLUME 101

p. 50, line 5	for: <i>T. recifese</i>	read: <i>T. recifense</i>
p. 85, line 38	for: <i>Lecanora crytella</i>	read: <i>Lecanora cyrtella</i>

VOLUME 103

p. 198, last line	for: <i>Skeletocutis roseolus</i>	read: <i>Skeletocutis roseola</i>
p. 235, ABSTR. line 8	for: <i>grummosopilosus</i>	read: <i>grumosopilosus</i>

VOLUME 105

p. 31(TAB. col.2, line6)	for: <i>P. amoenerosea</i>	read: <i>P. amoene-roseus</i>
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VOLUME 107

p. 18, line 3	for: <i>Psudocercospora bonducellae</i>	read: <i>Pseudocercospora bonducellae</i>
p. 32, line 25	for: <i>entomoloïdes</i>	read: <i>entolomoides</i>

VOLUME 108

p.53, line 24	for: from subgen.	read: from <i>Boletus</i> subgen.
p. 235, ABSTR, line 7	for: <i>D. muraliicola</i>	read: <i>D. muralicola</i>
p. 239, line 32	for: <i>D. muraliicola</i>	read: <i>D. muralicola</i>

VOLUME 109

p. 76, line 8	for: <i>amoeneroseus</i>	read: <i>amoene-roseus</i>
p. 79, line 8	for: <i>P. amoeneroseus</i>	read: <i>P. amoene-roseus</i>
p. 80, FIG. line 5	for: <i>amoeneroseus</i>	read: <i>amoene-roseus</i>
p. 252, line 14	for: <i>Dac. ellipsosporum</i>	read: <i>Dac. ellipsospora</i>
line 25	for: <i>Dac. haptotylum</i>	read: <i>Dac. haptoptyla</i>
p. 297, FIG. line 3	for: <i>D. tritici-repentis</i>	read: <i>D. tritici-repentis</i>
FIG. line 8	for: <i>C. intermedius</i>	read: <i>C. intermedia</i>
p. 399, ABSTR. line 2	for: <i>H. obpyriform</i>	read: <i>H. obpyriforme</i>
p. 410, line 16	for: <i>pseudomicrosporum</i>	read: <i>pseudomicrosorum</i>
p. 514	for: <i>Moellerodiscus coprosomae</i> ... p. 439	read: ... p. 437
	for: <i>Oxyporus piceicola</i> ... p. 314	read: p. 308

VOLUME 111

p.113, ABSTRACT, lines 4–6	for: <i>Aspicilia moenium</i> , <i>Lecanora albellula</i> , <i>Pertusaria pupillaris</i> , <i>Porina aenea</i> , and <i>Rinodina fatiscens</i> are new to Turkey. read: <i>Aspicilia moenium</i> is new to Turkey.	
p.491, line 17	for: It s	read: It is
p.491, line 34	delete the words: rather than gyrophoric acid	
p.492, line 21	for: under site of lobe margins	read: underside of lobe margins
p.493, line 2	for: It occurs on bark ...	read: It occurs on bark ...
p.493, line 32	for: ... from <i>X. verrucigera</i> in the chemistry, since it contains ... read: ... from <i>X. verrucigera</i> in their chemistry, since it contains ...	
p.502, line 1	for: (turkey)	read: (Turkey)

REVIEWERS—VOLUME ONE HUNDRED TWELVE

The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers prepared for this volume.

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MYCOTAXON BECOMES AN ONLINE JOURNAL IN 2011

FROM THE *EDITOR-IN-CHIEF*

MYCOTAXON ONLINE! — After three months of consideration, we have decided to convert our journal from a print medium into an **exclusively online publication**, beginning with the January–March 2011 volume, MYCOTAXON 115. To facilitate the most seamless transition possible, we shall make all papers from MYCOTAXON 2010 volumes available for free download over the next few months. Our table of contents, abstracts, book reviews, nomenclatural novelties are already online, and we now host almost 70 previously summarized annotated distributional species lists on our online resources page.

The decision to make this revolutionary change was not easily reached. Many on the editorial staff and advisory board initially resisted the changeover, formally proposed by MYCOTAXON founding editor Dick Korf in mid-February. However, a judicial cost-benefit analysis shows that the move is both timely and wise. Even the most inveterate bibliophiles among us confess (some rather shame-facedly) that we have come to depend on easily searched PDF files for our own individual research. For instance, I now find a reference much more quickly on a laptop than when I walk the few steps over to my now over-loaded library shelves to ferret out the pertinent passage on the correct page in the proper volume.

Although a print version will no longer be available after our final 2010 volume, there are many benefits to both subscribers and authors. One important plus is that as many color plates as authors wish to include will now be available at no cost to us (or them!). We will reduce subscription rates, as we will eliminate virtually all of the printing and mailing costs, which will soon be needed only to cover mailing printed volumes to selected libraries as required by the International Code of Botanical Nomenclature. We are simultaneously “going green” and advancing the future of publishing. More information and regular updates about the journal’s radical change are available at

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- Korf RP. 2007. On the genus *Solenopezia* (Fungi: Lachnaceae) and ICBN Art. 58—a sleeping dog bites back. Bol. Soc. Argent. Bot. 43: 29-32.
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NOMENCLATURE — Mycotaxon has long listed the new taxa, new taxonomic combinations, and new names in the end pages of each volume. However, readers have had to read the papers to learn that an already named taxon has been typified. We now include this previously overlooked information in our newly expanded NOMENCLATURAL NOVELTIES AND TYPIFICATIONS page. We also now supply the basionym for each 'nom. nov.' within our lists — particularly helpful as it provides a link between a previously 'known' name and a new 'unknown' one.

In 2009 we initiated a formal NOMENCLATURE SECTION that printed IN TOTO new conservation/rejection proposals currently being evaluated by the IAPT permanent Nomenclature Committee for *Fungi* (CF) as well as formal Committee reports, proposals to amend the CODE that directly affect fungal nomenclature, and spirited opinion pieces on nomenclature. All formal proposals, however, are first (or contemporaneously) published in TAXON, which posts them for free download on its website, <www.ingentaconnect.com/content/iapt/tax>. We have decided to offer MYCOTAXON readers only brief proposal summaries and the URL where the complete proposal can be downloaded. Our Nomenclature section will therefore resume in Mycotaxon 113 in an abbreviated form: although we will only summarize the formal proposals, we still welcome original papers from those wishing to comment on any proposal still under consideration by the CF.

MYCOTAXON 112—Our 2010 April–June volume contributes 91 new fungal names and typifications in 46 papers by 143 authors and co-authors representing 24 countries and assisted by 88 expert reviewers. As always, authors include many excellent drawings and photographs, and we wish to draw attention to the subtle blues and browns in the lovely full-color plate of several new entolomas described from the Primorsky Territory in Russia on page 233. Enjoy!

Warm regards,
Lorelei Norvell,
MYCOTAXON *Editor-in-Chief*
6 June 2010

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MYCOTAXON's complete instructions, which were last updated in January, 2010, are posted on the INSTRUCTIONS TO AUTHORS page on the MYCOTAXON website listed below. Prospective authors should download instructions PDF, expert reviewer comment and submission forms, and helpful templates by clicking the 'file download page' link on the instructions page before preparing a paper intending for the journal. Below is a summary of our simple '4-step' publication process.

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